THE

ELECTRICAL REVIEW.

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THE

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1899

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CENTRAL STATION PRACTICE IN GREAT BRITAIN.

IN the *Engineering Magazine* for May appears an article on the above subject. We presume the intention of the writer, as is usual in such cases, is to give information to those who are more or less ignorant of the matter dealt with. Unfortunately the article contains a number of statements which are manifestly erroneous.

After giving a brief history of the Electric Lighting Act of 1882, and the Amendment of 1888, he says: "Electric lighting legislation in England generally may therefore be regarded as the outcome of *expressed engineering experience*" (italics are ours). We believe we are expressing the opinion of every central station engineer, as well as every consulting engineer of experience, when we say that the Electric Lighting Acts are, without doubt, far more the result of ignorance than of experience. Its full title (1882) is "An Act to Facilitate and Regulate the Supply of Electricity for Lighting and other Purposes in Great Britain and Ireland," and in order to "facilitate" (?) the supply, the objectionable Clause 27, which rendered company promotion impossible was included. If the promoter of the Bill had taken the trouble to have a few minutes chat with any financier, he would have learned that such a clause was absurd. Even the repeal of that clause in 1888 only removed the most burdensome of a number of absurdly restrictive clauses, and the power vested in the Board of Trade has not conduced to the lightening of the burden placed upon undertakers. Over and over again has been pointed out to the Board of Trade the necessity of its modifying its regulations in several respects, and also of its endeavouring to get certain amendments in the Act, but without avail.

The article goes on to say "The Act of 1888, by giving statutory powers to electric supply companies to acquire land compulsorily for the erection of central stations," &c. How anyone in the business could make such a statement we fail to understand, probably everybody is well aware that this is one of the most serious omissions in the Act, and is a single illustration of many similar absurdities; the undertakers being required by the Act to do certain things and at the same time being debarred from the necessary powers to enable them properly to carry out such requisitions. The compulsory purchase of property is one of the greatest necessities in London to-day to enable electric lighting to be carried on, and its omission in the Act is one of the arguments put forward by those desirous of promoting companies for the supply of electricity in bulk by erecting stations outside the metropolis.

Further on the article states, "Certain broad principles on which the work should be carried out having received recognition by engineers in every part of the world, attention was devoted to perfecting the details of distribution." We should much like to know what these "broad principles" are upon which engineers are agreed. Except on the *very* broad principle that a motor and generator are necessary, engineers are certainly anything but agreed even in England, much less "in every part of the world." We believe a Committee of the Institution of Electrical Engineers has been sitting for some time with the object of bringing English engineers into something like agreement upon broad principles by standardising pressure, periodicity, &c.

At the top of page 208 we read, "The profits of electric lighting being comparatively so meagre," &c., while on page 209 appears the following paragraph, "Many towns in which electric lighting would have been 10 years ago a failure from a pecuniary standpoint, are now equipped with the central lighting station plant, which not only gives an admirable service, but yields a *handsome* return on the capital invested" (italics ours), while further down it states that "Central stations which are earning dividends are *very* numerous" (italics ours). These statements appear somewhat contradictory!

Amongst minor mistakes is that contained in the statement, "Early central stations were put down on one of two principles, either low tension direct current supply at 100 volts or high tension alternate current supply, generating at 1,000 volts, and transforming down to a 100 at the consumers' lamps by means of transformers installed on the premises." As far as we know, the only supply at 1,000 volts alternating was that of the Metropolitan Company, the pressure being almost invariably 2,000 volts or more.

In some places the writer gives a definite opinion, based upon very indefinite data, for example:—"Water-power, costing nothing per horse-power (!) appears a much cheaper fuel (sic) than coal at 15s. a ton; but if, in order to utilise the water-power it is necessary to put down mains of great length, costing many thousands of pounds, the interest on the capital outlay in connection with these mains *will* (italics ours) represent far more than the cost of fuel at 15s. a ton burned at a works in close proximity to the area throughout which current is distributed." Surely, whether or not the coal would be cheaper than the water-power at "nothing per horse-power" depends upon the number of tons "at 15s. a ton" consumed per annum in relation to the *number* of "thousands of pounds for mains." After stating the desirability of locating the works as near the centre of the district to be supplied as possible, the writer admits that there are exceptional circumstances which sometimes justify its being located at a distance, and goes on to say, "At Cheltenham, for instance, the works, which are a municipal concern, are placed about a mile and a half from the centre of the town. This site was adopted because the refuse destructor is situated in this position, the land owned by the Corporation, and a chimney stack used for the destructor, can also be utilised for the electric light works. Also, the Midland Railway Company passes so close to the site that coal can be conveyed to the works without carting and *unloading* (!) (italics ours). The shaft for the refuse destructor being already constructed, and there being a 70-H.P. boiler already available, the *cost of the works* (italics ours) has been kept exceedingly low." Alas for the illustration! As a matter of fact, the cost per kw. is high!

One would scarcely expect in these days to come across the following passage:—

"Recently—in fact, during the last two or three years—the manufacture of incandescent lamps has so far advanced, that the 200-volt lamp has passed from a laboratory curiosity to a commercial article, and, while the life of these lamps is still somewhat below that of the 100-volt lamp, the efficiency is greater, which, with the *considerable reduction in the first cost* of the lamps that has taken place during the last few years, represents an economy *in current* which may far more than compensate for the shorter life of the lamp and extra cost consequent on more frequent renewals. *The introduction of the 200-volt lamp* has enabled central stations to *double their customers* without further outlay for mains, *and with very little further outlay for generating plant*; so that by the adoption of the three-wire system, *twice as many lamps can be supplied as formerly* with a given set of mains *and a given generating plant*, and by the adoption, in addition of the 200-volt lamp, *four times as many lamps as formerly*." (Italics are ours.)

Whether the writer wishes to imply that the three-wire system has increased the efficiency of the 100-volt lamp twofold, or whether the combination of the three-wire system and the 200-volt lamp has increased the efficiency of the generating plant fourfold, we leave our readers to decide.

Magnetism.

We begin in another column a reprint of the "James Forrest" lecture of the year, delivered by Prof. J. A. Ewing before the Institution of Civil Engineers. The lecturer began with an apology for dealing with so large a subject. It is evidently impossible to cover the ground properly, including as it does the properties of iron and steel, the electro-magnetic theory of light, terrestrial magnetism, telegraphy, wireless and otherwise, dynamic electricity, and many other things, such as the travels of St. Paul and Provençal poetry. General discourses on the march of electrical events are trite *ad nauseam*, and everything that can be said has been repeated many times. This lecture is little more than a selection of bits of well-known detailed knowledge, mainly from Prof. Ewing's own work, and hardly attempts any broad survey of the subject. The literary interest, however, is considerable, for it is well constructed and gracefully expressed; and these are very considerable merits.

New Form of Induction Coil.—At the last meeting of the Society of Arts of the Massachusetts Institute of Technology, on April 27th, Mr. T. B. Kinraide, of the Spring Park Laboratory, Jamaica Plain, Mass., presented an unique form of induction coil of great power invented by him. This has been especially applied to the study of discharges by the aid of photographic processes, the plate being balanced on the point of discharge in a dark room, and being developed after exposure. It reveals in a striking manner the marked difference that exists between the positive and negative discharges. The apparatus was exhibited in operation and photographic plates shown with the lantern. The figures thus produced by the electric discharge were of extraordinary beauty and size, the delicacy of detail being brought out by means of the lantern. It is thought they may be suggestive of forms useful to designers and decorators.

ELECTRICAL RADIATION.

By J. E. TAYLOR.

(*Concluded from page* 795.)

In his theory of the transfer of energy in an electric circuit, Poynting has shown how an electric current consists in the motion of lines of strain broadside on, their ends gliding over the surface of the conductor. Now, when a Hertzian system is set in oscillation, and it always does oscillate at discharge if the conditions of resistance, capacity, and self-induction are not out of adjustment relatively to

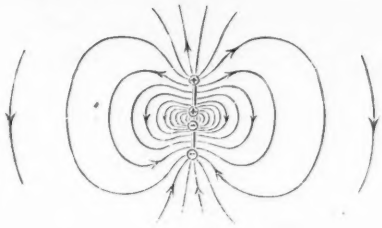


Fig. 3.

one another, and if the discharge be made sudden and sharp by using discharging knobs, which are well polished or immersed in some liquid insulating dielectric, the equivalent of a current rapidly reversing itself along the discharging system is obtained. This means that the ends of the lines of strain constituting the field of force move inwards from both ends, gliding over the surface of the conductor.

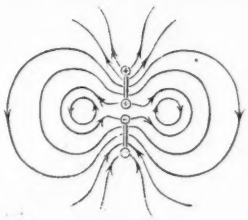


Fig. 4.

Thus, in figs. 3, 4, and 5, the action which goes on about the Hertz dumb-bell radiator is crudely depicted. Fig. 3 shows the state of the electric field before discharge. In this case only electric lines of strain exist. When the discharge takes place between the two parts of the radiator, a current is said to flow from the upper to the lower. In the

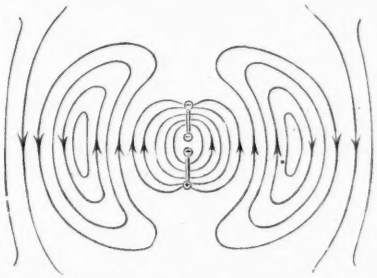


Fig. 5.

language of Poynting, this means that the positive ends of the lines of strain glide downwards and the negative upwards. The outer parts of the lines also move inwards to contract themselves, as it were, but this motion, as far, at any rate, as the extreme outer portions of the field are concerned, is relatively slow. Consequently, the positive and negative ends of the lines meet half-way. They cannot cross one another, but sever their connection with the conductor and join together to form self-closed lines of strain, and are thereafter independent. This stage is shown in fig. 4.

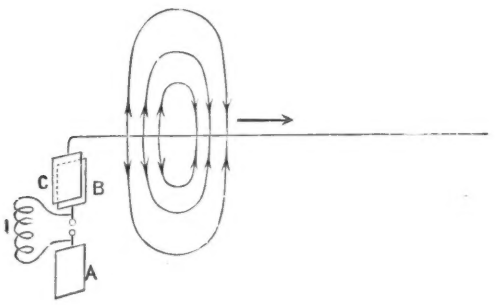
Going back again to Poynting's theory, just as a changing or moving magnetic field generates electric strain, so when the broadside motion of strain operates, a magnetic field is generated at right angles to the motion and to the electric lines. This implies the formation of magnetic circles round the system. At the end of a half oscillation, or quarter period, the electric lines connected to the conductors have altogether disappeared, and, with the exception of the detached parts of the field, their place is taken by magnetic lines. At this period, also, the current strength is at its maximum. The next thing that happens is, that the magnetic circles begin to contract themselves upon the conductors, moving inwards all round. This motion generates a new electric field, but in the reverse direction to the old one. At the same time, some of the energy of the system is being lost in heating the conductors. This is due to the magnetic circles close to the surface moving into the conductor, and there, no doubt, generating electric lines of molecular dimensions. At a further stage, a complete reversal of the original electric field has occurred, and the magnetic field has again disappeared. This is the stage represented in fig. 5, and occurs at the completion of an oscillation or half period. The same process then goes on again, more of the field becoming detached, and again until all the energy of the system has disappeared, or the remaining energy is not sufficient to maintain the spark at the gap.

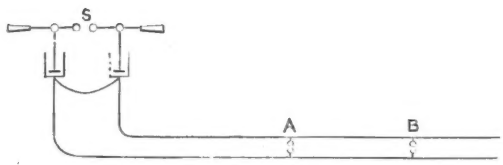
The broken off or detached portions of the field are propagated outwards, assuming a more and more spherical shape as they expand, but retaining the same thickness of shell, and these constitute electrical radiation. The velocity with which they travel is the same as that of light, and they can be dealt with in much the same manner. In fig. 5 only the electric characteristics of these waves are depicted, but in reality a magnetic field at right angles and in the same phase is associated with the electric lines. The magnetic and electric energies are also exactly equally to one another. The detached portions of the field simply travel radially outwards as expanding shells, and do not in themselves oscillate or vibrate in any way, but are necessarily the cause of oscillations in any conductors which may be in their path. Such conductors cut pieces out of them and produce electromagnetic shadows, and although in the case of long waves the shadows are not well defined, the shorter the waves the better becomes the definition, independently of the distance of the source.

As far as Marconi's reflector experiments are concerned, the above explanation of the kind of effect generated applies. With his vertical wire system the explanation is somewhat different, and some experiments of Hertz and of Lodge on the propagation of waves in wires will have to be touched on to show what occurs in the latter case. A great deal of mystery has been made of this, but the generation of the effect involved is not altogether new.

Among his many researches Hertz tried a number of experiments on the transmission of electric waves along wires, and on the interference between these and the direct or "space-propagated" wave. His arrangement was substantially that shown in fig. 6, where I is an induction coil, which is connected to one of his plate radiators, A, B. A third plate, C, was placed a little distance behind A, and to this was attached the wire along which the waves were propagated. As a matter of fact, he might have attached his wire direct to A, but this would have upset the arrangements for adjusting the strength of the waves. By a similar sort of process of redistribution of the lines of electric strain to that we have just been considering, electric fields of the kind depicted on the wire in fig. 6, are formed and propagated along the wire. The lines of strain, here shown, are not self-closed. They terminate with both ends on the same conductor. Nevertheless, they are electric waves and fulfil the conditions for propagation, and move along the wire with about the velocity of light until they come to the end. There they are reflected, as it were, back again, and if the length of the wire is adjusted to some multiple of the wave length, interference results and fixed nodes are formed at various points on the wire. This electric wave has also a magnetic field, and the propagation of the wave means in popular phraseology that oscillatory electric currents are set up along a certain length of the wire corresponding to the half wave length. These currents continue until the energy is frittered away in heat. The method of depicting the wave as shown in fig. 6 is due to Hertz.

There is also a similar experiment, and a very beautiful one due to Lodge. A slight modification of his arrangement is shown in fig. 7. Two Leyden jars are charged in series by means of an influence machine or coil, and discharged also in series and on short circuit, the two outer coatings being joined by a short wire. Two very long wires are led parallel from the ends of this



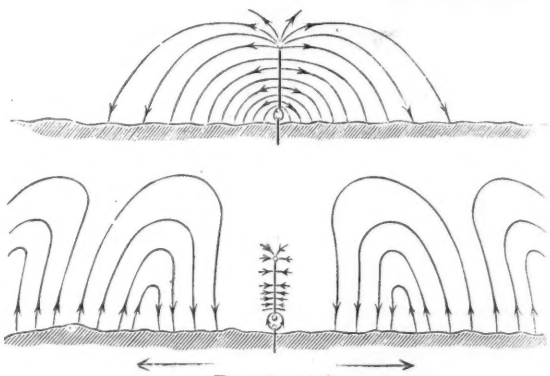


Figs. 6 and 7.

short wire, and the exact lengths adjusted to a multiple of the wave lengths of the oscillations in the jar circuit. Waves are generated in both wires at every discharge, not so powerfully, perhaps, as in Hertz's arrangement, but quite sufficient for the purpose, nevertheless, and these two sets of waves are in opposite phase. On placing a spark gap at A, where there is, say, a node, no spark, or only a very small one, is obtained. At B, however, further away from the source, comparatively vigorous discharges are obtained. These effects are due to the same form of waves as Hertz generated by his device. Prof. Lodge calls them electric surgings, but perhaps the term is not a very happy one, as its meaning is liable to be misunderstood.

If the wires, or one of them, were put to earth instead of being insulated, the waves would pass on, and skim or glide over the surface of the earth till further orders. Again, if the wire were bent into a loop the waves would follow round the loop. If one jar and one wire only were used, waves would still be propagated. Considering this arrangement of one jar and one wire for a moment, have we not got all the essential parts of Marconi's vertical wire system? The insulated vertical wire is one coating of the jar. The earth's surface at the base of the wire is the other coating, and the earth itself takes the place of the attached wire. Again, in Marconi's system we have not only all the conditions for an oscillatory discharge but the conditions for about the most powerful wave producing effect. Instead of the electric field being confined as in the jar it is spread out into the surrounding space as in fig. 8. When the discharge occurs the ends of the lines glide down the wire and so to the earth and form waves similar to those of Hertz, which propagated themselves along wires. In this case the waves, in the shape of huge concentric circles travel out radially, not into space, but skimming over the surface of the ground in the way shown in fig. 9. The magnetic field accompanying the moving field of electric strain is in the shape of concentric circles, which, on account of their large circumference, are of small density, just as round a wire of large diameter the magnetic field is of relatively small density. Since the absorption of energy by the earth is, according to Poynting's theory, proportional to the density of the magnetic field at the surface of the earth and to the resistance of the earth, it follows that this absorption is only small, and is, moreover, less when the conductivity of the earth is greater. This, no doubt, accounts for the better effects obtained over sea than land. Since with this form of wave there is no reflection from the earth into space, there is an additional reason for the distances over which effects are obtainable. As a matter of fact, the intensity of the waves should not be much less than inversely as the distance from the source. Combining this with the increase of dimensions of the wave with increase of height of the vertical wire, the result of the variation of distance with the square of the height is obtained. The earth connection, or its equivalent, is essential to this system if distances are to be obtained, as, with an ordinary Hertzian arrangement with vertical conductors, but without the earth connection, radiation into space and reflection from the earth into space must ensue.

The reason why hills do not offer great obstruction is pretty clear, as the waves travel over them just as they travel



Figs. 8 and 9.

over the bent or looped wire in Hertz's or Lodge's experiments. The curvature of the earth should not affect transmission, and if sufficiently powerful effects are produced, transmission over any distance should be possible. The question of interference still remains, however.

As regards the wave length of these oscillations, there is probably not much doubt that it is in the neighbourhood of four times the length of the vertical wire, because the waves generated are practically the bisection of an ordinary Hertzian arrangement continued below the earth's surface to a depth equal to the height above, and the wave length of such a system would be twice the total length or thereabouts. Calculating on this basis, it works out that in the transmission from the South Foreland to Boulogne, Marconi uses waves 600 feet long, and oscillations of a frequency of about 1·6 millions per second.

The essential feature of Marconi's system is doubtless the earth connection. His coherers, though good, are not necessarily more sensitive than other forms.

The waves transmitted from the source in this system cause what may in popular phraseology be called oscillatory electric currents in the skin of the earth's crust. We, therefore, have concentric circles of current having a radial direction travelling outwards from the source.

Little enough is as yet known concerning the behaviour of such currents or, more properly, waves, and experiments in this connection will not be lost from a scientific point of view. It is probable that their reflection by earthed conductors is possible since they set up corresponding currents in such conductors, but very large reflectors would have to be constructed for the purpose.

Marconi has stated that he prefers erecting a vertical wire for supermarine transmission on the beach close to the sea rather than on high cliffs. Such an arrangement probably gives a better effect, and for the reason that better oscillations are obtained due to the superior conductivity of the earth at the base of the wire.

Alternating Current Arc Lighting at Earl's Court Exhibition.—Among the many new features introduced in the lighting of the Earl's Court Exhibition, is a system of arc lighting from step-up transformers, which we hope to describe in a future issue.

THE SCOTCH WATER-POWER DEVELOPMENT SCHEME.

On Tuesday, May 2nd, the Parliamentary Committee charged with the consideration of the scheme of the Highland Water-Power Syndicate, completed the hearing of the evidence for and against the Bill, and later on the same day they delivered their decision—that the preamble of the Bill had not been proved by the promoters. The scheme is therefore wrecked at this, the first, stage in its path towards realisation.

The scheme, as many of our readers are no doubt aware, was backed by such well-known men as Lord Kelvin, Lord Tweedmouth, and Mr. C. Macrae, and had for its object the development of 40,000 H.P. on the shores of Loch Leven. The aims and plans of the promoters cannot be better presented than in the *Times* summary of the speech of Mr. Pope, Q.C., the counsel for the Bill :—

Mr. Pope, Q.C., in opening the case for the promotors, remarked that the measure involved questions of more interest and importance than were usually met with in a private Bill discussion. To a certain extent its proposals were novel, and they were of what he might almost call national importance. It was a matter of common knowledge that the supremacy which Great Britain formerly held in the markets of the world with regard to certain industries had now been taken from her by some of her trade rivals. This was to be said of the chemical trade, which had gradually become a German industry. Within the last few years electricity had been made use of as a re-agent in disintegrating masses to be dealt with in chemical manufacture. In the alkali trade, for instance, it was found that an electric current was a more powerful re-agent than any which had hitherto been employed, with the result that, inasmuch as the employment of electric power depended on the cheapness with which it could be produced, the alkali trade was passing rather out of the hands of the English manufacturer and going into those of foreign manufacturers, who were able to avail themselves of the cheapest possible form of water-power. The Bill was promoted by a number of gentlemen who believed it to be the essential duty of those who were interested in the industrial pursuits of the country to render available as far as possible the natural agencies existing at our own doors. These gentlemen included the Earl of Crawford, Lord Tweedmouth, Lord Kelvin, and Lord Farquhar. It was obvious, therefore, that this was no gingerbread scheme. The proposal was to raise the waters of Loch Ericht some 14 feet higher than at present by constructing a dam at the lower end of the loch. Water from the loch would then be conveyed through tunnels and aqueducts to the head of Loch Leven, where it would be used for generating power. It was believed that the utilisation of this power would bring together a manufacturing community on the shores of Loch Leven, which would be the embryo of a large manufacturing industry The promoters did not propose themselves to engage in specific industries, but they had no doubt that if they could provide cheap power there would be plenty of applicants for it. There was a second and subsidiary scheme by which a large reservoir would be formed out of a series of small lochs extending westward to Loch Inbhir, and additional water-power would thus be obtained. The plans of the promoters had created much enthusiasm in the Highlands, because it was believed that they would afford means of employment to the crofter population. One of the effects of the scheme would be to divert the surplus waters of Loch Ericht from Loch Rannoch and eventually from the River Tay; in fact, from the east to the west coast of Scotland. In order, however, to provide compensation water, the promoters proposed to dam up Loch Laidon and to periodically discharge from it into Loch Rannoch, and so into the Tay, sufficient water to compensate for the loss of the Loch Ericht water.

The opponents of the Bill were Sir J. Ramsden, Sir R. Menzies, Sir J. Stirling-Maxwell, as landowners; the County Council of Perthshire, the Town Council of Perth, and the Tay District Board of Salmon Fishing as public bodies. The opposition may be broadly distinguished as personal and public; the landowners were disturbed in mind as to the probable effects of the scheme upon their deer shooting; the public bodies as to its effects upon their water supplies. The compensation offered by the promoters was in neither case held to be satisfactory, and thus a scheme which Mr. Pope rightly described as of almost national importance has been wrecked upon questions which certainly ought to have admitted of compromise.

Those of our readers who have read the articles and notes which appear from time to time in our columns relating to electro-chemical and electro-metallurgical industries, will know the tendency that exists for these new industries to group themselves at centres of cheap power. Niagara in America, Savoy in France, and Rheinfelden in Germany, are rapidly becoming chemical centres of considerable importance. Our country cannot afford to neglect her resources of similar forms of power. The delay that has already occurred has certainly been detrimental to our industrial prosperity.

The opponents of the scheme of the Highland Water-Power Syndicate ought to have recognised these more important aspects of the question; and the desire to preserve deer-parks and water supplies exactly in their present condition would have been more commendable if moderated by a larger conception of public duty.

Our country has become great by the development of its manufactures; it can only remain great by continuance in this path of progress. No personal or local considerations ought to be permitted to hinder this expansion; and we cannot regard as patriotic the spirit shown by the opponents of the scheme we are discussing, nor as wise the attitude of the committee which gave undue weight to the arguments of the opposition.

We trust that the Highland Water-Power Syndicate will next Session renew the attempt to obtain Parliamentary sanction for this scheme, and we hope that in the intervening period every effort will be made to effect a compromise as regards compensation, with the chief opponents of the scheme.

ELECTRIC LOCOMOTIVES.

(*Concluded from page* 793.)

A diagram may now be constructed in which ordinates represent velocity in miles per hour, and abscissæ represent the time of a journey over one section. In the present case this length is 130 seconds. Then, if from each end of the base line sloping lines be drawn upwards and towards each other at the inclination representing the rate of acceleration, and these lines be prolonged indefinitely, they will meet finally at a point and form a triangle.

In the diagram given by the author the deceleration is constant, or such as will stop a train running at 20 miles per hour in 20 seconds. Six different rates of acceleration are given, from 1·46 down to ·417 feet per second. With equal rates of acceleration and deceleration of 1·46 feet per second, the two inclined lines are joined by a horizonal at the height of 16·25 miles velocity. The trapezoidal figure is then the speed "curve" for the conditions named. If, however, other rates of acceleration be chosen the horizontal line must be drawn at a higher level, and if all the speed curves are made to enclose the same area the upper line will represent by its height above base, the speed at which the train must run after acceleration has ceased, and the time during which it must maintain the speed. A speed curve is thus compounded of an inclined acceleration line, a horizontal line of even running and a sloping line of deceleration. For the lowest rate of acceleration of ·417 feet per second the accelerating force must be kept on for 90 seconds, or nearly so; even running only continues for about 15 seconds, and is done at 25½ miles per hour velocity, and stopping requires 20 seconds as arranged, whereas for the maximum acceleration of 1·46 feet per second only about 16·3 seconds are occupied in acceleration, about 97·4 are run at even speed of 16½ miles, and stopping requires 16·3 seconds. Thus, the more rapid acceleration implies a much lower maximum speed, and this means less work to be done by the brakes and less loss of energy. But if so high a speed as 25½ miles per hour is allowable on a section, it is perfectly obvious that the initial acceleration of 1·46 feet per second might be continued until the maximum allowable speed had been attained. This maximum speed might be maintained as long as necessary. The train might then be allowed to run by inertia, the speed "curve" for this being a line much more inclined from the vertical, as the braking line and the brakes would be applied when this line met the line of deceleration. Such a speed curve is thus formed with an inclined acceleration line, a flat-running line, a free coasting line of flat inclination, and the sharply inclined braking line. Just as the author's more rapidly accelerated curves are more economical than the curves of lower acceleration, so will the suggested maximum speed curve be still more economical. No suggestion is advanced on this system of running, but it is a system much followed in America. Speed

is got up to the maximum which can be allowed by the use of such powerful motors as would, if more powerful, cause the wheels to slip on the rails. In other words, the adhesion is utilised to the uttermost. If the section is long, speed is maintained at the maximum for a time, after which the train is allowed to run by momentum up to the time the brakes are to be applied. The point of brake application is earlier or later according as the time can be allowed. It is determined as between this time and the amount of energy which can be afforded to be wasted. The author sets a limit to the time allowance on a section. On a busy line this limit does not enter into calculation. It becomes a question not of spending so many seconds on a section, but of running at the maximum velocity possible, the time spent on a section being determined by the maximum speed allowed and by the maximum energy to be wasted by the brakes. The following gives a few of the results as calculated for the extreme rates of acceleration per second of 1·46 feet per second and ·417 feet per second. We reproduce the extremes only.

Seconds to attain 20 miles per hour.	Acceleration feet per second.	lb. seconds for acceleration.	lb. seconds for acceleration and tractive resistance.	lb. seconds tractive resistance.	lb. seconds running period.	Total lb. seconds for 2,700 feet.	Percentage increase due to acceleration.	Percentage increase in total lb. seconds.
20	1·46	81,100	95,220	14,120	77,400	172,620	Standard.	Standard.
40	·730	89,400	119,540	30,140	63,150	182,690	10·24 %	5·84 %
70	·417	126,800	204,300	77,500	16,070	220,370	56·4 %	27·65 %

This table shows clearly the great economy from rapid acceleration. The author points out that there is a wide margin of choice without increasing the expense of energy more than 6 per cent., and he appears to recommend some reduction in the size of motors, and the maximum tractive effort they are to be called on to supply at the moment of starting and first few seconds run. Thus, the speed curve would rise in a curve, not in a perfectly straight line, and whereas a tractive force of 7,125 lbs. is necessary on the face of acceleration of 1·46 feet per second it may be reduced to 5,839 lbs. over the starting period.

It remains to find how far the findings can be carried out in practice, bearing in mind that space is limited. From the table of performance of motors (ELECTRICAL REVIEW, May 12th, 1899), No. 4 motor is seen to have given the best results. Its maximum speed was 20 miles per hour, corresponding to an average acceleration of from ·584 to ·487 feet per second during the starting period. This is about 12 per cent. more extravagant than the standard, neglecting motor efficiency. Could the speed curve be kept straight during acceleration better results would be attained, but the back E.M.F. of the motor is a bar to this, and the nearest approach to this desirable result must be aimed at, and is to be secured by keeping up the current by shunting the field when the current commences to drop. This reduces the tractive force per ampere, but the performance diagrams show that it is far more economical to successively shunt the field to a certain point when the motors are in series before going into parallel, and again to shunt the field after placing the motors in parallel until the sparking limit is reached, or the tractive force per ampere has fallen so low that further acceleration cannot longer be economically obtained. If at this point the field be unshunted, the current and traction will drop, and the locomotive will run at the required or the designed speed. Taking No. 4 motor again, a fresh performance diagram shows that, with the starting current limited to 150 amperes, the fields may be shunted 50 per cent. at 1·4 miles per hour when the current has fallen to 114 amperes. It will then rise to 142 amperes, and at five miles per hour will again have dropped to 114 amperes, when the field may be shunted 66 per cent., and 138 amperes of current will flow. Ordinarily the current would have been only 55 amperes at this point with less tractive force.

At six miles per hour the motors are put into parallel at a limit of 300 amperes. At 11 miles per hour this has fallen to 228, when the 50 per cent. shunt is used, and the flow rises to 300 again, and falls to 236 at 13 miles per hour, when the 66 per cent. shunt is used and 302 amperes of flow attained, which fall to 223 at 16 miles per hour, at which speed the shunts are no longer employed, the current drops to 97, and falls gradually to 76 at 18 miles per hour. The run is completed in 128·5 seconds, at an expenditure of 1,477 watt-hours. As compared with the performance diagram of the same motor, unshunted during the starting period, a flow of 115 amperes is obtained for 60 seconds, as against only 77 amperes when the shunt was not used, while the watt-hours, now 1,477, were 1,624. The time has been lengthened 1·9 seconds, or 1½ per cent., but the economy of current has been 8·86 per cent. The same motor, using the 50 per cent. shunt only and in parallel only required 1·17 per cent. more time to run the section, though at the same expense of current. Obviously, in place of only two shunts, there might be six or more without undue complication of the controller, beginning, say, at 10 per cent. and going up to 60 or 70 per cent., whereby the curve would be kept more even. Trying the same arrangement with No. 3 motor of 1,134 conductors shows 1·96 per cent. of time saved and 2·89 per cent. of energy, the saving being only small and pointing to the armature being short. Taking No. 2, with 972 conductors, and armature increased 50 per cent. in length, this motor, now called No. 5, shows a greater tractive force per ampere than No. 4, but at a slower speed for equal tractive effort, and the performance diagram showed it necessary to use a third shunt in the parallel running, and even then the time on the section would be 132·5 seconds, an increase on No. 4 of 2·87 per cent. in time and 1·29 per cent. of energy showing apparently that the most economical design had been found in No. 4. As tractive force is a product of useful magnetic field and numbers of conductors for a given current, No. 5 should apparently have done better, and it is surmised at this point that some relation exists between number of conductors and strength of field for the same armature diameter that will give best results. Hence arose No. 6 motor, designed for an equal rail traction of 2,900 lbs. at 150 amperes and 761 lbs. at 50 amperes. The armature was doubled in length over No. 1. There were 729 conductors, and at 430 volts a speed of 8·6 miles per hour can be obtained, the tractive force per motor being 2,900. At 10 miles per hour this is 1,650 lbs. at 90 amperes, whereas No. 5 only gave 1,320 lbs. for 75 amperes, No. 6 using more current and giving more power. No. 6 could thus run the section in 128·5 seconds for 1,330 watt-hours, which may now be compared with the original No. 1 running the section in 130 seconds, and using 1,905 watt-hours. Yet, commercially, No. 1 is just as efficient as No. 6. It is not, however, designed so exactly to its conditions. Size limits prevent any further alteration, except in winding.

So far the investigations were on paper. To put some of the figures to the test of actual practice, the motors of No. 3 engine of the same type as No. 12 were rewound with 810 conductors in place of 540, and a series parallel controller was added. The result was that No. 3 saved 15·8 per cent. in time on the round trip from Stockwell to the City and back; but it used 13,150 watt-hours in place of 12,100 used by No. 12. But though this does not look much of an economy, it means a good deal. The average maximum speed was 21·3, as against 18·5 miles per hour, and this represents energy in the proportion of 1,296 to 931, or 39 per cent. more energy in the acceleration. No. 3 is more efficient at starting than No. 12, showing 46·1 per cent. on the drawbar against 29 per cent. of No. 12, and 65·5 at the rail against 52·35 of No. 12. No. 3 showed 27·6 per cent. $C^2 R$ losses. No. 12 showed 23·5 per cent., but in external regulating resistance No. 3 only had 4 per cent. loss, and No. 12 had 21 per cent. But during running No. 12 was 3 per cent. more efficient than No. 3. This appears to show careful original design, though perhaps with too much thought for long runs as against frequent starts and stops.

There is a great amount of information in this paper, but

the main gist of the paper and all it contains is to the effect that the series parallel system of control is the best at present known. It has shown itself capable of very greatly reducing the external losses which arise in regulating an electrical motor, losses which some engineers are apt to describe as paralleling the throttling of steam to a steam engine. But this is not exactly a fair parallel. The loss in an external resistance, which is made hot by the electric current and dissipates its heat to the external atmosphere is a much more serious loss—more serious especially in principle. It may be likened rather to the method of regulating a steam engine by means of a brake on the fly-wheel, or more accurately still, it is like liberally swabbing the steam pipe with water to reduce the amount and pressure of steam.

But, after all, is not the series parallel system of control already realised as the best? Is it not in regular operation over thousands of miles of line, and, so far as the main purpose of this paper is concerned, does it not seem a pity to throw away so much energy in re-demonstrating this recognised fact? We are apt to complain that Americans waste a lot of time and energy in discussing what has been proved long before in England. Here is an example of the same kind. The author practically decides that the series parallel method is the best, or at least better than the previously existing arrangements. He also finds the great benefit from high acceleration, but this is an old story and has long been the practice on American lines, and has proved, as it may be proved theoretically also, the best means of securing rapid average journey speed at a minimum expenditure of energy. The use of gradients both to and from all stations, as on the Shepherd's Bush line, was advocated nearly 20 years ago as sound practice, and it will work in well with the rapid acceleration system, and serve to transfer energy, otherwise expended at the brakes, to the starting of a train.

The paper contains a number of tables. As these relate to performances that may be expected and which have been to some extent verified in fact, they will be useful as references in getting out figures for new plant. In this respect, however, the weights of motors and of train do not appear in the tables, and must be taken from the body of the paper, and so far detracts somewhat from their value.

We say this without wishing to detract from the credit due to the author of the paper, who must have spent much time and trouble on its preparation.

AN UNSOLICITED COMPANIONSHIP.

[Contributed]

It is generally supposed that the influence of fashion is dominant only among ladies and very young men. That the potent, grave and reverend signiors of our Town Councils should be ruled by it and the work of our engineers seriously affected by it will be scouted as absurd. But it is true all the same, only the fashion is not in quite the same article.

This is the law of fashion. Suddenly something that is not particularly good nor eminently bad gets taken up and run after in a way for which its merits supply no adequate explanation. Everybody gets it and praises it because it is *the thing*, except a minority who abuse it with equal vehemence and want of reason. This has the effect of an excellent advertisement and makes it more the rage than ever.

It is now several years since Maude, who had been playing tennis, was told by her brother, at home for the holidays, that a little leather strap was an excellent thing for a weak wrist. So she had one made that looked nice, and tried it. It did not do much in the way of strengthening the wrist, but it looked effective and attracted attention. Alice and Mary and the others noticed that too, and weakness in the wrist was in danger of becoming as infectious and as persistent as influenza if it had not occurred to a brilliant genius on the other side of the shop counter that if you stuck a watch in the strap that would not only furnish an excuse for wearing it, but make the whole affair look nearly as smart as a bracelet. Moreover, it could be worn when a bracelet is "impossible," for instance, out bicycling. So the three guinea watch was taken out of its place of safety, and shaken about and made to suffer untold things in order to justify the existence of a three and sixpenny leather strap. This, of course, was many years ago. All girls are sensible nowadays and merely wonder how people could have been so silly as to think that on the wrist was a suitable place to wear a watch. After a little while the thing became "common," the fashion dropped as suddenly as it had arisen, and all the watches that had not been irretrievably smashed during the period of exposure went back into their original location—usually somewhat damaged.

For years we have had the dust destructor in the land and it never excited the smallest enthusiasm. No one suggested that the waterworks engineer should take it up, or that it would add to the amenities of the sewage works. In fact, it was looked on as a necessary nuisance in certain cases. But now, like Maude's wrist strap, instead of being something that one is not proud of it has suddenly become all the rage, and no corporation "is complete without one." A dust destructor is not quite as cheap as a leather strap but it is not ruinously expensive, and there would be no objection to a harmless fancy if it did not induce a desire to have the electric lighting station attached to it. Now, an electric generating station is a delicate and expensive bit of business, and it seems rather stupid to hamper the electric power supply by making it depend for its support upon what is essentially an arrangement for causing a rubbish heap to burn away without smoking or smelling more than reason and the inspector will put up with.

It is supposed that the municipal mind has been taken by the symmetry of the idea. Like Maude's strap it looks so trim and neat. Here is the nice little town, why not endow it with a nice little electricity station and make up for the wastefulness of working in quite a small way by getting all its power for nothing from a nice little dust destructor? Just like a German toy village as pretty as paint can make it.

So the Council's Committee goes to the consulting engineer and asks him if he can give them a combined electric generating station and dust destructor. The engineer being an electrical engineer, and not a sanitary man, naturally knows little about dust destructors, and next to nothing about dust, except that it is something that is ruinous to the working of electrical machinery, and must, at all events, be kept out of the engine room.

So he looks up the matter, sees that "there are absolutely no engineering difficulties in the way," and reports accordingly. If he did not—but he knows better than to baulk them. Besides, if there is any subsequent trouble it does not fall upon the consultant but upon the resident engineer, who finds that the difficulties of regular and economical running are considerably enhanced when he is not allowed to stoke his fires as he chooses, but must make steam at such times and in such quantities as suit the convenience of the dust carts. So the resident engineer not being yet appointed, the Corporation in blissful ignorance contemplates a dust destructor to support its electric light station, and do things cheaper.

In all seriousness the objection to the dust destructor as a source of power is, first, that it gives so very little, and, next, that the supply is so intermittent and incalculable. The quantity of the refuse fluctuates from month to month, and from day to day, and, what is worse, its quality varies even more. In the summer the cinders from household fires are mostly absent. In the winter, when the load is heaviest, anything or nothing may come in according to the weather. If, indeed, there happens to be a fall of snow then the supply stops altogether, because all the energies of the Corporation's carts are devoted to clearing the streets.

In electric lighting or electric traction absolute continuity of supply is the essence of the contract. A destructor is not fit for the burning of coal just the same as if the concentration of the fuel is carried a degree farther. A coal grate does not do to burn petroleum, so there must be duplicate arrangements ready in case the supply of heat from the destructor fails. The latter at best can be only an auxiliary, and an auxiliary that cannot be relied upon is apt to become a disastrous nuisance. Meanwhile interest has to be paid on the capital that provided the substitute. Were it not that young consultants consent and councillors eagerly press it, the utter futility of this attempt to scrap up a modicum of unpaid for power would seem self-evident.

Why this way more than any other? Every electric lighting station has immediately at hand a source of considerable power which is absolutely gratuitous, and in the application of which to various industrial purposes there is longer experience than in almost any other part of mechanical engineering. Moreover, it is clean, and it does not require to be carried to the station, but comes of itself. The cost of a specially built destructor would go a long way in windmill sails. But the mental condition of the engineer who should recommend a windmill at each corner of the roof of the generating station would be a subject of grave concern to his friends. The supply of power so obtainable is simply of no practical use for the purpose because it is intermittent. Sometimes there is more than can be done with and sometimes there is none at all. The case is strictly analogous, but fortunately for the electrical engineer, windmills are out fashion, or since it seems the fate of electricity supply to be burdened with the support of every fad that can be hung upon it there is no telling what might happen. At present, instead of being sent to the hill-tops for wind, or being tied up to the public baths and wash-houses (because the exhaust steam or condenser water might be used for heating), the generating station is banished to an unsuitable locality in order to suit the convenience of the dust carts. Whether these or some other fads may follow no man can safely say. The operations of the mind that is ready to devote to this sort of saving of candle ends an amount of capital expenditure that might do something useful are beyond all comprehension. The only thing certain is that the fashion, like all fashions, will not last very long, and the town will discover that the dust destructor is not a good place to wear its electric lighting station. Then, perhaps, the dust destructor may be put to the rough work for which it is really fit, and of which in many towns, with stables and stone yards and street repairing and paving work always going on, there is always something on hand. *E pulvero lux et vis* is a quotation the authorship of which has never been revealed by the classics of Shoreditch. But when it is considered with all its context, there is no doubt that the correct meaning of it will be found to be that electric light and power had better come clear away from the dust demolition department. Meanwhile, however, the way in which this hangs its ungrateful companionship on to the electric power station constitutes a serious menace to a cheap supply. The conditions for the most economic generation of electricity now demand a considerable section of the country and a varied demand, light, power, and traction.

A dust destructor, which is necessarily local, is utterly inconsistent with these conditions.

TELEGRAPH PAPERS AT THE INSTITUTION OF ELECTRICAL ENGINEERS.

Following upon what we said in our last issue, we take this opportunity of making a few further remarks of the way in which Mr. Elton Young's recent paper at the Institution of Electrical Engineers was treated by the ruling spirits of the Institution.

This paper was taken as read on April 27th after three members of council (all "learned professors") had spoken for about 20 minutes on the subject of the paper preceding it—partly, be it noted, in answer to one another. Though Mr. Young's paper was taken as read, it soon became pretty obvious that this was not in order to leave more time for its discussion, but to leave full time for the reading of another paper, which reading rapidly cleared the room; and we very much doubt whether the discussion on this will be curtailed in the same way—by no one being allowed to speak for over the 10 minutes. Much was said about the latter paper being one of very great importance, and there can be no question that it well comes under that head; but are not *all* the Institution papers of considerable importance? We fancy that some of the "powers that be" cannot properly appreciate that Mr. Young's paper may be of just as much immediate importance from a general standpoint—even though it has to do with an old-established branch of electrical engineering—as other papers dealing with subjects with which they may happen to be more familiar. Perhaps these gentlemen are not aware that in long sections of cable such as we may see more of in the immediate future—in connection with Imperial telegraphy—the problem of accurate capacity tests is one on which a good deal of money may depend. Moreover, for the same reason, it is highly desirable to arrive at an accurate modification of the K R law.

Would it not be well also to remember that even now far more capital is involved in submarine telegraphy than in any branch of electrical work, and that, after all, the Institution was initially established by telegraph men? As things tend at present, it seems likely that the few telegraph papers with which the Institution are troubled nowadays will go to the parent Institution—the Institution of Civil Engineers—or some other body, if such scant attention is given to them. Perhaps, however, that is precisely what certain gentlemen would like.

Be this as it may, speakers were warned by the chairman that the part of Mr. Young's paper touched on by our esteemed past-president, Mr. Siemens, was not within the sphere of debate, though the president of the year had previously allowed them to be discussed, and though, as we believe, the chairman (no matter who he be) represents the president in his absence. It is often scant consolation to know that any further remarks will be printed in the *Journal* of the Institution; and there will, we imagine, be many who would prefer their remarks being given in full in the electrical press—for those associated with the subject to have an opportunity of seeing almost immediately after the reading of the paper—and who will remedy the matter accordingly.

THE FULHAM ELECTRIC LIGHTING CONTRACT.

A little comedy of errors has been enacted at Fulham in which vestrymen, contractors, a dog cart, brougham, and consulting engineer have all played their parts; indeed, as a theatre of varieties the Fulham Vestry Hall last week would have been hard to beat. Unfortunately it was painfully apparent that some of the *dramatis personæ* had ill-rehearsed their parts, while others showed some histrionic ability, but the piece was badly stage-managed and kept the boards for one night only.

Seriously, we have not space to devote to the voluminous correspondence which ensued between Mr. Tom Green, chairman of the Electricity Committee, and the consulting engineer; nor for the lengthy statement prepared and read by Mr. Hirst, of the General Electric Company, to vindicate his position in the matter at issue, but so far as a careful perusal of this documentary evidence and a report of the last Vestry meeting, reported at length in the *Fulham Chronicle*, of May 12th, the facts appear to us to be as follows:—

The Vestry recently invited tenders from a few selected firms for the equipment of the new electric lighting station and the laying of mains in the parish.

The electrical plant consisted of steam alternators of the two-phase type, steam exciters, motors, switchboards, rectifiers, testing instruments, mains, arc lamp posts, lamps and fittings, and sub-station equipment.

We are not aware that the General Electric Company would have experienced any difficulty in complying with the terms of the specification, notwithstanding that it would have been their initial experience in central station work, but there seems to be no doubt that the company's tender was seriously considered, and naturally everybody must make a beginning. The company's tender was the lowest, and from the moment this was made known the consulting engineer seems to have tried to move Heaven and earth to relieve the General Electric of its responsibility and to place the work with some of its competitors.

Whether Mr. Medhurst invited the company to tender, as Mr. Hirst asserts, or not, the company by the mere fact of being allowed to tender, was presumably capable of carrying out a contract for something more than "switches, fittings, &c.," and Mr. Medhurst should have excluded Mr. Hirst's firm from the beginning if he had any reasonable doubt of their inability to conform to the terms of the specification. Why

did he not do so? His admission, too, that he was unaware that the General Electric made a speciality of the type of alternators required at Fulham, does not do credit to his usual acumen, since we made this fact known nearly two years ago.

It is stated in the *Municipal Journal and London* that when the several sections of the tenders were examined, it was discovered that the General Electric Company had put down £750 for river pipes, whereas the other firms had quoted £2,000, and in one instance as much as £6,500. Subsequently the General Electric Company intimated to the Vestry that a mistake of £1,000 had been made in this particular item, and asked permission to amend. This the Vestry declined to do, and the firm then agreed to stand by their original figures. This, by the way, appears to be merely a side issue, and the attempt to make a mountain out of a molehill signally failed, the sub-contractor for these pipes standing to his guns and backing up the General Electric Company.

In his report upon the tenders, the consulting engineer suggested that a saving could be effected by dividing the work into two sections, and he selected two firms, the British Insulated Wire Company, Limited (whose general tender was the highest in the whole list), and Messrs. Johnson and Phillips (fourth on the list), to carry out the two portions of the work. The engineer expressed dissatisfaction with the tender of the General Electric Company, but the chairman of the committee, Mr. Tom Green, entered into a lengthy personal correspondence with the engineer, and also had an interview with him in the hope of persuading him to recommend the acceptance of the General Electric Company. A threat was even made by Mr. Green that he would resign his seat on the Vestry and retire from public life in Fulham altogether unless his wishes were complied with, and altogether Mr. Green seems to have acted fearlessly.

The action of Messrs. Musgrave was quite in keeping with their own interests, and under the circumstances perfectly natural and what one would expect from a firm of such standing.

The sub-committee met last Monday week in order to decide what tender should be recommended for acceptance. The engineer, we are assured, in the ordinary course would have been present, although it does not seem to us that his presence was necessary, the decision resting with the members of the Vestry, but Mr. Green, it is said, took upon himself the responsibility of instructing the clerk to inform Mr. Medhurst that the time of meeting had been postponed for half an hour. When the consulting engineer arrived on the scene he found that the committee had met at the usual hour and that the whole matter had been cut and dried. The tender of the General Electric Company was recommended to the Vestry for acceptance in disregard of the engineer's advice.

Mr. Medhurst then took action. He brought to the notice of the Vestry Mr. Green's interview with himself, and also their correspondence, and the Vestry decided to send the whole matter back to the committee for further investigation.

At the last meeting of the Vestry, to which we refer more fully on another page, the statements made by Mr. Hirst and Mr. Medhurst were diametrically opposed, but there was a frankness about the former's explanation of how the General Electric Company became connected with the matter which carries conviction with it; moreover, as the circumstances of the case are comparatively recent, and considering this was the first transaction of the kind in which the company had been engaged, it is not improbable that Mr. Hirst's memory would be more fresh than that of Mr. Medhurst, who has several other undertakings of a similar nature to occupy his mind.

At the end of an acrimonious discussion amongst the members of the Vestry, and mutual recriminations between contractor and consulting engineer, the proposition to give the work to the General Electric Company was carried by a considerable majority, an amendment, which had the support of the consulting engineer, to the effect that the contract be split up and again advertised, being lost, and so ended in a farcical manner the first act of the Fulham comedy of errors.

When we have, once for all, adopted a standard set of wiring rules which shall be binding on all engaged in electric lighting, we would jocularly suggest that the Institution of Electrical Engineers might nominate a committee to draw up a set of rules on the etiquette of the profession for the guidance of consulting engineers; and the London Chamber of Commerce might do worse than issue a treatise on the commercial morality of the present day with hints to vestrymen on the correct manner of carrying out the obligations which are imposed upon them by the parishioners who elect them as representatives of their views.

So far as we can see, in this instance, however, there seems to be no cause for suggesting that any jobbery or canvassing led to the acceptance of the General Electric Company's tender, and the committee adopted the usual course of recommending the lowest, all other things being equal.

We have no concern with local politics or local feeling, and if we have not fully grasped the situation we shall be prepared to give both sides the opportunity of supplying us with further explanations, although we candidly confess that the consulting engineer appears to have only himself to blame for the strained relations which exist between him and the committee. A very sensitive and less pugnacious engineer would, we should think, in the above circumstances, resign his position, for he can hardly be expected to continue therein without considerable friction arising between him and the contractors, and also the committee.

ELECTRICAL PUMPING IN SOUTH STAFFORDSHIRE.

To an engineer who contemplates the utilisation of the resources of nature from the point of view which is inimical to the wastefulness of small efforts, there can be no more painful subject than South Staffordshire. The country has been brought low by its very richness. In the vicinity of Dudley the coal seams are immense, one which is nominally 10 yards thick occurring in places as much as 12 yards. Coal is near the surface, moreover—indeed, we hear of a sewer being actually laid in solid coal, and we know where a working man simply mines coal for his own household use out of his cellar, and such trivial riches as fireclay may be seen dug out of the holes in which the poles for the electric tramways are now being placed. Owing to this very ease in mining it has come about that little men of small means have been able to set about coal mining. As a result of this, the tubbing has often been very inferior, and the upper waters have been let down into the lower strata and millions of tons of coal drowned out. Then, again, the system of mining has been such as to seriously disturb the superincumbent strata and render easy the admission of surface waters.

Hence the large amount of pumping found necessary in the South Staffordshire coal field. The first real step at curing the mischief was taken in 1865, when the British Association visited Birmingham. Investigation then showed that much of the water pumped from the mines merely ran back at the surface faults, at the "swags" or depressions caused by the mining operations. Canals and streams also contributed a lot of water. As a result of the investigation, Parliamentary powers were sought in 1872, and under the stimulus of fear of loss of all the mines, the South Staffordshire Mines Drainage Act of 1873 was passed. Everyone, including the canal companies, were favourable to the repair of the surface, and supported the measure. Surface repair was made separate from pumping and separately rated. Mr. E. B. Marten and Mr. Edmund Howl read a paper on the subjects in September last before the Institute of Mining Engineers. They dealt with a surface of 75 miles—more especially with the 32 miles of the Tipton district, where electric power is proposed to be used. From the mines of this district no fewer than 36 millions of gallons per day were raised by 120 engines, and some progress was made when the Commissioners put down modern engines and acquired a few of the best old ones.

Since 1873 the surface repairs had decreased the amount to be raised to 9 million gallons only, but the water does not come to the pumps so freely as it should. Large areas are still pounded up and the coal rendered inaccessible. It is now desired to still further mend the surface, reduce the water to 6 millions of gallons, and reduce that in the now

drowned pounds referred to by means of smaller semi-portable plant. The increased plant will not be permanent, for as the mines are opened up passages can be made to the large regular pumps, which are in the right places and fully equal to the work.

The surface works include purchase and removal of many water mills and the reduction of the level of main streams, also clearing and straightening streams to a uniform gradient and rendering their channels water-tight from the source right through the broken ground. In 1895 a combined surface repair and pumping scheme was brought out, including a hydraulic power distribution main for semi-portable plants and for actuating surface pumps for draining the low-lying surface areas. Underground levels have been driven. Owing to continued settlement and solidification of certain previously broken areas which have been under water since 1877, the water did not percolate even with a head of 102 feet. Thus the Commissioners were face to face with the difficulty of either an underground level from the pumps to every colliery or of again separate pumps at each colliery. As the total water is now only a fourth of what it was, it appears as though the funds ought to be available for effecting anything desired. But the output is now only 600,000 tons in the Tipton districts, where it was formerly 2,660,000, so that the Commissioners are now pumping 24 tons of water per ton of coal where they formerly only pumped 22 tons; and private pumps are raising another 6½ tons of water. Thus, while the present pumps are ample, the revenue cannot afford the expense of a multiplicity of stations. At the time this apparent deadlock presented itself, the Midland Electric Corporation for Power Distribution gave notice of its intention to apply for an order to supply electrical energy.

Practically there was no opposition from the Tipton mines drainage area, which has been re-examined with a view to the employment of electrically-worked pumps for the low lying surfaces. Probably fast running centrifugal pumps will be employed, as these are suited for electrical working and moderate lifts such as this surface drainage requires. They could be arranged very readily to start and stop automatically by means of a float in a water tank. Their lifts would be 10 to 20 feet, and they would be of inestimable value in promptly dealing with storm water, preventing its soaking in, and thus dealing with it at lifts of 20 feet in place of at lifts of 400 to 600 feet should it enter the mines.

A great advantage of electrical pumps is that they can be all started at once if a rain storm comes on. At present, if stopped, an outside pump cannot be set to work until steam can be got up. The "swags" will be kept constantly at a low level. Old limestone quarries, which are now simply sumps for letting water down below, and are most difficult of access for fuel and plant, can be easily fitted with an electrical plant. Generally the authors made out an exceedingly good case for electrical working. It is only a matter of surprise that they did not suggest the employment of the huge volumes of gas escaping practically unused from the South Staffordshire blast furnaces, in order to work gas engines to produce the electricity to work the pumps. One industry should react on another. A demand for such power gas should encourage the re-opening of furnaces, and of the ironstone mines of the Tipton district. The discussion which ensued was not of great importance—not up to the level of the paper. Mr. Hy. Davey was appreciative, and the Rev. G. M. Capell, the inventor of the Capell fan, spoke to the use of centrifugal pumps in series, which lifted water 150 feet. He was much in favour of the system proposed, and unlike another speaker, saw no difficulty in the automatic starting of the pumps. Mr. C. E. Turner said that much loss of current would be caused by the splash of the pumps.

Has Mr. Turner ever seen a centrifugal pump? In reply to the discussion, Mr. Howl said that the plants proposed would be 2½ to 5 H.P. only. They would have a capacity of 25 million gallons, but would not average above 3 millions. The Supply Company would supply at the low cost of 3d. per unit for the first hour, and 0·825d. for the second and succeeding hours per B.O.T. unit. The best engines now used, cost 3d. per 25,000 gallons raised 100 feet. If electricity cost four or five times as much per H.P., it would still save money by catching the water at the surface, *i.e.*, by reducing the pumping head perhaps 10 or 20, or even 30-fold. The object of the Commissioners is to reduce the percolation, than to get communication underground from the pounds to the main engines. This done and coal unwatered, the increased output would quickly reduce the tonnage rate.

Altogether, the paper was one of particular interest, for it showed how an agent, nominally more costly than steam power, could be produced by steam power at a distance and used in such a way as to effect a given purpose with economy. It was not the electricity which gave the economy. The saving was not in the amount of water pumped. It was in the head to be pumped, or rather the head which was not pumped that economy was secured. If the South Staffordshire people would stir themselves up a little, throw on the scrap heap about half or two-thirds of their old worn-out plant, abandon their old-fashioned notions, and learn reasonable economy, they might, and could compete with any district. There is no reason why they should not remedy the evils that have come upon them by reason of their early errors, and which have clung to them through their own short-sighted policy. But when we read of the county authorities doing all they can to thwart electrical traction and see large and populous districts practically without any means of transport, we begin to realise how it is that South Staffordshire has fallen out of the running, and find foreign-made material going into the very heart of the Black Country.

Truly the people of the district need a thorough shaking up. Possibly, when a few of the now constructing lines of the British Electric Traction Company are in full work, they may serve to waken the people up to a knowledge that South Staffordshire is not the centre of all wisdom.

CORRESPONDENCE.

Electric Cars.

A possible mode of support for electric cars that has suggested itself is, two fixed contiguous axles at the centre for driving and brake purposes, and radial axles, or even bogies, for support *only*, at either end.

Alfred J. Allen.

London Institution, E.C.
May 16th.

Okes-Serve Boiler.

I observe that in your description of this boiler in last week's number, you take exception to the use of a lock and key for the sluice valve.

This device had reference to a "screw-down" blow-off valve, as illustrated, but in place of these plug cocks can be employed for the blow-off, and by a simple lever arrangement both sluice and blow-off valves are operated simultaneously. Thus when one is open the other is closed, and no possible danger can arise.

J. C. R. Okes.

LABOUR CLAUSES IN MUNICIPAL CONTRACTS.

The time has arrived for English engineering employers to assert their independence, to declare with no uncertain sound that they will no longer be over-ridden by the tyranny of dictatorial officials of the labour bureau; and we believe we make a statement of fact when we say that they intend to immediately take steps in that direction. "The king can do no wrong," say Socialists, when they imaginatively set up "Labour" as the supreme monarch. "The capitalist, the employer of labour, he, and he alone, is a hydra-headed monster, oppressing the weak, and grinding the faces of the poor." But this "monster" has during the last year shaken himself, and has freed himself from the cords of a fanciful eight hours day movement, and now he will rise in all his glory superior to interference, either direct or indirect, on the part of labour. Not that it is intended for one moment to take any unworthy advantage of the worker by the exercise of brute force. That is left to trade unionists, who rush headlong into strikes to their own and everybody's else disadvantage. What it is proposed to do is to obtain a freer hand in regard to municipal contracts.

On several occasions recently we have indicated the ways in which

employers are handicapped by certain clauses in contracts given out by municipalities, clauses whose main feature is their extreme inconsistency and unreasonableness. West Ham is a particular instance of this kind of thing. The works of a firm of contractors (Messrs. S. Z. de Ferranti, Limited) being situated within the *Oldham* district, that firms pays its workmen at the rates of wages recognised by the trade unions in that district. But when its tender was submitted and accepted for the West Ham electrical plant contract, the Town Council calmly insisted that the wages paid should be those prevailing in the *Manchester* district with which neither the Council nor Messrs. Ferranti have any connection whatsoever.

The firm immediately refused to execute the contract under such onerous conditions, and West Ham decided to invite fresh tenders, with the result that, although many estimates were sent in, Messrs. Ferranti have received the contract unconditionally and with every vestige of labour clauses deleted. The firm in particular and employers in general are to be heartily congratulated upon gaining so complete a victory. There is more in this success than the West Ham authorities may at the moment perceive. For if so sweeping a victory is possible in the hotbed of Radicalism and the nest of extreme Socialism where may it not be possible? Whatever steps may be taken by employers of labour in the immediate or distant future, they will be greatly indebted to Messrs. Ferranti for having fought out the matter with such satisfactory results at West Ham. Our labour classes are very outspoken in their views regarding giving encouragement to home industries. It would be interesting to know whether they love their labour clauses so faithfully that they will permit contracts to be placed out of the country, and so discourage home industries. It seems that our manufacturers intend giving local authorities a choice between the two courses. Prohibitive labour clauses will not be countenanced, and working men will have the opportunity of deciding whether they will stick to these clauses and take the bread out of their own mouths by giving the work to Germany or America.

In the West Ham conditions, amongst other things, the contractor was asked to put up in the works a clearly written or printed copy of the schedule, which had to be filled up and inserted in the contract.

Our readers may imagine for themselves what it would mean if a contractor having a large number of municipal contracts, had to have a number of different notices under the heading of the different towns he was contracting for. There would be the possibility of a workman, who had the slightest complaint against the firm, at once getting into communication with the labour members of the particular town, and thus endless disputes would arise between the contractors and their workmen. The whole essence of the clauses is against the understanding arrived at, at the close of the engineers' strike, between the federation and the great unions. The unfairness of the conditions is proved by practically the whole of the engineering trades in England in tendering, deleting these clauses entirely. Messrs. Ferranti, in tendering, did what practically everyone else did, *i.e.*, refused to fill in the schedule, and struck out the whole of the conditions relating to labour.

It is of interest to quote the conditions as stated in the West Ham advertisement:—

"The contractor whose tender is accepted, and with whom a contract is entered into, will be required to pay all workmen employed by him in or about the contract such rates of pay, and observe such hours of labour as are embodied in the schedule, which will be part of the contract. In the event of any breach of such agreement the Council will enforce the penalty clause in its entirety.

"A tender will not be accepted unless it is stated by the contractor in the tender, and proved to the satisfaction of the Council, that the contractor at the date of the tender pays to the whole of his workmen such rates of wages, and observes such hours of labour as are recognised by the workmen's trade unions in the several localities where his work is done. If after the contract is signed it shall be proved that the said statements of the contractor in the tender are contrary to fact, the Council shall be entitled to rescind the contract, or, at its option, to recover from the contractor as liquidated damages, and not as a penalty, the sum of £50."

In striking out these clauses Messrs. Ferranti said:—

"We may state that we are now paying our men fair rates of wages, and that we observe fair conditions of labour throughout our works (both these points having been fully investigated recently by your committee and engineer). We are prepared to continue to do so during the time this contract is in force, and we are prepared to allow your engineer to verify this at our works from time to time."

The following are extracts from the West Ham general conditions as to rates of pay and hours of labour:—

"The contractor shall pay all workmen (except a reasonable number of legally bound apprentices) employed by him in and about the execution of this contract, or any part thereof, wages, and wages for overtime respectively, at rates not less than the rates stated or provided for in the schedule hereto, and for each and every breach by the contractor of this stipulation, and notwithstanding the condonation of any prior or other breach, the contractor shall, on demand, pay to the Council as liquidated damages, and not as a penalty, the sum of £5.

"The contractor shall observe, and cause to be observed, by such workmen, hours of labour not greater than the hours of labour stated or provided for in the said schedule, and for each and every breach by the contractor of this stipulation, and notwithstanding the condonation of any prior or other breach, the contractor shall, on demand, pay to the Council as liquidated damages, and not as a penalty, for each day or week, as the case may be, in which any such breach shall be committed, and for each workman in respect to whom it was committed, the sum of 5*s.* per hour for every hour during which, in each day or week, as the case may be, each such workman shall be employed by the contractor beyond the maximum number of hours stated or provided for in the said schedule, provided that this stipulation shall not be construed to prohibit overtime, if such overtime be in accordance with the rules of the trade unions concerned.

"The contractor shall at all times during the continuance of this contract display, and keep displayed, upon the site of the works, and in every factory, workshop, or place occupied or used by the contractor in or about the execution of this contract, in a position in which the same may be easily read by all workmen employed by the contractor in or about the execution of this contract, a clearly printed or written copy of the said schedule hereto, and for each and every breach by the contractor of this stipulation, and notwithstanding the condonation of any prior or other breach, the contractor shall on demand pay to the Council as liquidated damages, and not as a penalty, for every day during which such breach shall be or continue, the sum of £3."

While we are upon this subject a valuable circular comes to hand from the Employers' Parliamentary Council, in which we find facts and figures extracted from a recently issued Parliamentary return, showing to what extent local authorities throughout the United Kingdom insert labour conditions in their contracts, and the character thereof.

Conditions as to wages vary very much in different localities, and are classified under the following main heads:—(1) Current rates, (2) rates recognised by trade unions, (3) rates agreed on by associations of employers and employed, (4) rates fixed in contract. The conditions included in each of these classes are not absolutely identical. Some authorities require the wages paid to be those in force within their own jurisdiction; others, again, specify that they shall be those in the district where the work is executed. In some cases the stipulation applies merely to the contract itself; in other cases it is required that the contractors' workmen generally shall be treated on the same footing.

Current rates are required to be paid in the case of contracts with 31 county boroughs.

The same condition is also contained in the contracts of 37 non-county boroughs and 47 other urban districts, making a total of 115 local authorities.

Rates recognised by trades unions are required to be paid by 10 county boroughs.

The same condition is enforced by seven non-county boroughs and 17 other urban districts, making a total of 34 local authorities.

Rates agreed on by associations of employers and employed are required to be paid by six county boroughs. The same rates are stipulated for by one non-county borough and three other urban districts, making a total of 10 local authorities.

Rates are fixed by the contracts of five authorities. In two cases (West Ham county borough and one urban district) provision is made for payment only of day rates of wages.

As to conditions as to hours of labour, 14 county boroughs require that the generally recognised hours of labour of the district or trade shall be observed.

The same condition is made by 16 non-county boroughs, and by 13 other urban districts, making 43 authorities in all. Trade union conditions are enforced by three county boroughs.

One non-county borough and five other urban districts compel similar acquiescence on the part of their contractors, giving a total of nine authorities.

Contractors are bound to abide by hours agreed on by associations of employers and employed for three county boroughs and three urban districts.

Other conditions, while not being so common as conditions as to wages and hours, are of a very varied character and difficult to classify. The most usual is a condition against sub-contracting, which is inserted in the contracts of 10 county boroughs.

It is also adopted by eight non-county boroughs, and 12 other urban districts. The power to dismiss workmen is reserved by the county boroughs of Dudley and Huddersfield, by three non-county boroughs, and by 31 other urban districts. The county borough of Gloucester and one urban district have passed a resolution that, in accepting contracts, preference is to be given to local tradesmen; four non-county boroughs and 14 other urban districts stipulate that their contractors shall, as far as practicable, employ local workmen.

In the instance of at least one county borough (Blackburn) the contract is endorsed with a recommendation on the subject of fair wages. In five other cases (Hanley, Sunderland, and three non-county boroughs), although no express provisions are inserted in the contracts, the advertisements inviting tenders require conformity with current rate of wages. One non-county borough has passed a typical resolution: "That no contract or contracts be given out from this Council to any firm or firms who do not pay the trades union rate of wages to the workpeople in their employ." In a great number of contracts the authorities demand the employment of *competent* workmen, and in several cases, a *responsible foreman* in charge is expressly provided for.

Brighton and one urban district provide for arbitration in cases of dispute with their contractors. Leeds, one non-county borough, and two other urban districts, require the keeping of wage and time books by the contractor for the Council's inspection, and Walsall a "true and correct statement of rate of wages paid to the several classes of workpeople employed." One non-county borough, on the other hand, while requiring current rates to be paid, expressly disowns any intention of imposing the condition that union men only be employed. In one urban district the contractor is required to insure his workmen against accidents. In another he is to be liable for all accidents happening at or in consequence of the works while in progress. In the case of two urban districts, for certain classes of work, workmen must not be under a specified age. One urban district, in requiring "that the contractors shall perform the whole of the work by proper workmen at trades union rate of wages," has almost reached the socialist ideal. The returns, it should be stated, refer to 64 county boroughs, 212 non-county boroughs, and 780 other urban districts.

In regard to the local authorities of Scotland, current rates of wages are required to be paid by the counties of Caithness, Orkney, and Sutherland. The same stipulation is made by 11 burghs.

Rates recognised by trade unions are not stipulated for by any county, but are specified in the contracts of the burghs of Clydebank and Perth. The condition is not actually enforced in Clydebank.

Rates of wages in contract are not specified by any county, and by only one burgh.

Four burghs of Dundee, Glasgow, Motherwell and Plaisley make a condition against sub-contracting. The lower ward of the county of Lanark and the burghs of Gourock and Paisley reserve the power to dismiss contractors' workmen.

Employment of local labour by preference is required by the counties of Caithness, Inverness and Sutherland.

In one case, that of Dundee, the contracts, in addition to providing for the payment of current rates of wages, require that the contractor shall observe the terms of any agreement that may have been mutually arranged between employers and workmen. Glasgow insists upon the right to inspection of records (which it compels the contractor to keep) of names of, wages paid to, and hours kept by, all workpeople employed on its contracts. Partick requires the observance of "the recognised hours and conditions of labour in each respective trade." It should be added that the return relates to 33 counties and 202 burghs.

The *Labour Gazette*, in its issue for April, 1898, states that 163 local authorities in England and Wales, with an aggregate population of over 8½ millions, include in their contracts conditions as to wages; and 219 local authorities, with a population of somewhat over 9½ millions, specify various conditions as to employment (including conditions as to wages). Eight hundred and sixty-seven local authorities, with a population of over 7⅔ millions, make no conditions as to employment in their contracts; but of these 11 indicate conditions which they desire to be observed, although not in the contract, and 41 have never made any contracts. It is calculated that the whole of the urban districts of England and Wales (including London, about which the return gives no information) may be divided into two groups, the first of which, with a population of about 13 millions, includes all districts where conditions of some kind of wages are imposed; and the second, with a population of about eight millions, includes all districts where no such conditions exist.

According to an article on the Scotch return in the *Labour Gazette* for April, 1899, 17 local authorities, with an aggregate population of a little over one and a-half millions, include in their contracts conditions as to wages, and 24 local authorities, with a population of nearly two millions, specify conditions as to employment (including conditions as to wages).

Two hundred and eleven local authorities, with a population of rather over two millions, make no conditions as to employment in their contracts.

The above particulars show the very large extent to which the local authorities of Great Britain have already adopted the system of dictating to contractors the way in which they are to carry out their contracts. The case which has occurred recently at West Ham in which this system of interference has been carried to an unprecedented extent is referred to above. As stated, some authorities require their contractors to pay the wages in force within the authorities' own districts, and some the wages in force where the work is executed; but it never appears to have occurred to any council before to enforce rates in a district with which neither party is connected.

This system of interfering with contractors not only imposes most unfair and onerous conditions upon them, but is distinctly prejudicial to the ratepayers, as contractors will naturally insist upon getting a higher price to compensate them for the vexatious conditions to which they have to submit. Many of the Councils, indeed, who have adopted this policy would not be at all sorry to drive away the contractors altogether, as they would then have an excuse for executing their work by direct labour. This, of course, is the worst system of all for the ratepayers, as has been fully proved by the extravagance and corruption in the works department of the London County Council.

AMERICAN CARBIDE WORKS.

By ORRIN E. DUNLAP.

The new plant of the Union Carbide Company, now in course of erection on the lands of the Niagara Falls Power Company at Niagara Falls, is destined to be the greatest works of its kind in the world, while it is also most suggestive of the wonderful growth this industry has made during the few years since the first factory for commercial purposes was erected at Niagara. With the exception of a few minor interruptions, the progress of the industry has been steady, and it has been an almost constant enlargement of the output capacity. Since the formation of the Union Carbide Company, a solid foundation appears to have been reached, and now the Niagara plants are jumping forward with great bounds.

This new carbide plant is located west of the line of the Niagara Junction Railway, and north of the tracks of the New York Central and Erie railroads. The site occupies several acres of the Power Company's land, and the direction of the buildings is north and south. The material used in the construction of the plant are principally brick and iron. The bricks come from Buffalo, while the Berlin Iron Bridge Company furnish the iron for structural work. The contractors are Wentworth & Taylor, a Niagara Falls firm that has had many large contracts in connection with the Niagara growth and development. The plant will consist of two factory buildings and an office building. Each of the factory buildings will be 864 feet in length, and have a width of 75 feet. They stand side by side about 80 feet apart. The front portion of the first building will be three stories high, or 53 feet to the eaves. In this section there will be three floors, 132 by 75 feet; this will be the pulverising department. The section of the building in the rear of this will be 30 feet to the eaves, and appear to be two stories, but in reality it will be one large room 30 feet long by 75 feet wide, with a high ceiling, and probably will be the dust collecting department.

Next will come the great furnace room; this will be 395 feet long by 75 feet wide. Off from this furnace room will be located the transformer rooms. Each building will have six of these distributing points for the current, three on each side of the furnace rooms. In the entire works there will be over 100 furnaces, and these are now being built by the Dobbie Foundry and Machine Company, of Niagara Falls. They will be of the latest improved continuous pattern, and contain all the points found to be necessary to their successful operation.

The shipping and packing department will follow in the rear of the furnace room. It will be 300 feet long × 75 feet wide, and an upper floor will be used for storage. However, it is not the expectation of the company to require much storage room, as there is a constantly increasing demand for their product. Railroad tracks will be laid through the centre of the shipping department, and there will be elevated platforms which will make it convenient to reach the car doors. In its buildings and about the site the company will have nearly 3½ miles of track, and they will have a locomotive of their own for switching purposes. With the exception of the three-story front section, the second building will be a duplicate of the first. This second building is going up rapidly. The output capacity of each building, when in full operation, will be over 50 tons a day, and the company expect that in manufactured product and raw material it will handle between 30 and 40 cars every day. It is the intention of the Union Carbide Company to develop the equipment of the two buildings, so that finally they will be consuming 25,000 electrical horse-power, which is the product of no less than five of the great generators in the central station of the Niagara Falls Power Company. The contracts call for the completion of the plant by July 1st of this year.

The electrical installation for the new carbide works has been ordered from the Wagner Electric Manufacturing Company and the Westinghouse Electric and Manufacturing Company. The contract made with the Wagner Company is said to be the largest transformer order ever placed in the United States. This contract calls for seven static transformers of 2,000 H.P. capacity each, and two static transformers of 500 H.P. output capacity each, all complete with switchboards for operating them. These transformers will be of the oil filled type, and have water coils for lowering the temperature of the oil. It is understood that the contract was closed on definite specifications as to iron and copper losses, full, ¾, ½, ¼, and $\frac{1}{10}$th load efficiency, guaranteed as to temperature rise, also as to insulation testing, with guarantees made as to 50 per cent. overload in current.

The Westinghouse Company will furnish the Union Carbide Company nearly 10,000 H.P. in transformer capacity, and these machines will be well up to the high standard of all the Westinghouse work. The Westinghouse Company has also received from the Niagara Falls Power Company an order for seven 2,500-H.P. transformers, involving the largest units manufactured. These transformers will be used in stepping up the two-phase 2,200-volt current from the generators in the central power station to three-phase 4,400-volt current for supplying the Union Carbide Company. They will be of the Westinghouse standard oil-insulated, water-cooled type, the cooling being effected by the circulation of water through coils of brass pipe immersed in oil, so that no fans, blowers, pumps or motors will be required, a construction that eliminates any loss of power in the revolving elements of auxiliary devices. In general appearance these transformers will be of the same type as built by the Westinghouse Company for the Cataract Power and Conduit Company of Buffalo and installed in the Ohio street transformer station of that company. It is expected that the efficiency of these transformers will be very high. At full load it will be considerably over 98 per cent.; at half load over 98 per cent.; and at quarter load over 97 per cent.

The storage bins for the new carbide plant will be supplied by the Penn Bridge Company, and the elevator and conveying machines by the Jeffrey Manufacturing Company.

The superintendent of the Union Carbide Company at the Falls is E. F. Price, and it is under his careful supervision that the new plant is being erected. He has had extended experience in carbide manufacture.

THE NERNST INCANDESCENT LAMP.*

A numerous assembly, consisting of representatives of science, electrical engineering, and members of the Haute Finance, met last night in the large hall of the Allgemeine Elektricitäts Gesellschaft to listen to a lecture given by Prof. Dr. Walter Nernst on the subject of his epoch-making invention in connection with electric lighting.

Mr. Rathenau, the director-general of the Allgemeine Elektricitäts Gesellschaft, addressed the audience, giving in the course of his speech a sketch of the development of electric lighting.

The speaker next referred in detail to the present position of the electrical industry, which he said created electric energy without at

* From the *Boersen Courir*, Berlin, May 10th, 1899.

the same time making the by-products, which in other trades play such an important part. The installation of the electric central stations, and more especially of the laying of cables, were extremely expensive items; in Berlin alone over 70,000,000 marks has been spent upon them. This made it most desirable that electrical engineers should, if possible, increase the capacity of the central stations. One of the best means for effecting this was reducing the amount of current required by the lamps; up to the present, however, certain difficulties had presented themselves, and it therefore required the adoption of a new principle to enable them to make a further step in advance. This was done by utilising bodies which so far had been considered as non-conductors.

Prof. Nernst has solved the question of enabling us to utilise the cables and central stations to the best advantage; he has done this by putting within our reach a cheap light, which, instead of being regarded as a luxury, will serve economically for ordinary household purposes. His lamp will neither supersede the Edison glow lamp nor the arc light, but will serve as a welcome addition to both of them. The Nernst light creates a new turning point in lighting, for it will penetrate into the workmen's houses and even into the abodes of the poor.

Prof. Nernst commenced his lecture by giving a sketch of the development of the electric lamps used up to the present. Both glow lamp, burning in vacuum, as well as the arc light, relied on glowing carbon as the foundation of their construction. Only a comparatively small part of the electric energy produced is turned into light. The speaker showed from a diagram that no less than 97 per cent. of the energy is expended uselessly in the form of heat rays, while only about 3 per cent. is transformed into light. A notable attempt at replacing carbon and metallic conductors by other substances was made by Jablochkoff with a lamp which, unfortunately, was only too soon discarded, and in which he conducted the electric current over thin sheets of kaolin, a fireproof material.

Prof. Nernst then exhibited a Jablochkoff lamp in action, which showed a fine steady light. The lecturer remarked he had only heard of this lamp after his own invention, and that he had pursued his studies without any knowledge of Jablochkoff's principle.

Prof. Nernst showed a number of models representing the development of his lamp. The first and most simple form requires the heating of the glowing body by a flame. This can be done with a match in the same manner and in the same time as lighting a candle.

Dr. Ochs invented a heating body worked automatically by the electric current. Another method of heating consists of a hood-shaped oven for the lamps. These lamps, which are rather large, the heating takes about 30 seconds, but in the smaller lamps only 10 to 20 seconds are required. Great interest was shown in the production of pictures of a lighted Welsbach mantle, which appeared on the screen as a faint blurred green silhouette.

The glowing body of the Nernst lamp first appeared on the screen as a narrow bond of light, which gradually became stronger and more concentrated until it resembled sunlight. Further experiments were made with a reflector, the intense light of which would prove especially valuable when used for clinical purposes.

In conclusion, Prof. Nernst pointed out the long way which had still to be traversed from the time when, to his great satisfaction, his lamp had worked beautifully in the laboratory. After much work he had, aided by able assistants, succeeded in producing a lamp which fully answers all the requirements for practical use.

After the lecture, the chief engineer of the Allgemeine Elektricitäts Gesellschaft followed with a series of technical explanations intended to show the practical advantages of the Nernst lamp. He especially referred to the colour of the light, and to the ease with which the lamp could be taken to pieces and the glowing body replaced; further, the small amount of current required and the low selling price. The latter appears especially low for the lamps without preliminary heating, while those with automatic lighting are dearer on account of the extensive use of platinum.

This platinum is, however, only consumed after burning for a very considerable time, and even then only partially. The lighting bodies, when carrying a heavy current, have a life of about 300 hours. Nernst lamps are chiefly made of 25, 50, and 100 candle-power, but some are also made of 480 candle-power.

Mr. Rathenau, in conclusion, informed his hearers that the wholesale production of the Nernst lamp by the Allgemeine Elektricitäts Gesellschaft would take place in a new factory, which they expected to have in thorough working order during the course of this summer.

The company hoped that, by means of the Nernst lamp, that part especially of the business would be reconquered for electric lighting which had been lost by the introduction of the Welsbach patents. He added that he attached great importance to the decision given on Tuesday last by the claims department of the patent office, by which all claims against the Nernst patents had been dismissed and the claims contained in the Nernst patents established as possessing full rights.

LONDON COUNTY COUNCIL.

At the weekly meeting on Tuesday it was decided to lend £25,000 to the Whitechapel Board of Works for the enlargement of the refuse destructor premises and for electric lighting purposes.

Electric Traction.

The adjourned report of the Highways Committee dealing with the fresh negotiations with the London United Tramways Company was again brought forward. It was unanimously resolved without any discussion to consent to the company applying for power to reconstruct on the overhead trolley system (1) the tramways in that part of Uxbridge Road between the Askew Arms public house and the railway station, and (2) from Uxbridge Road railway station *viâ* Goldhawk Road to Young's Corner, on condition that the company would undertake to reconstruct (3) the tramways from Young's Corner *viâ* King's Street to Hammersmith Broadway according to an underground system of electric traction. It was understood that when the time arrives for the purchase of those portions of the company's tramways which are situated within the county of London, the Council would pay to the company the "then value" of the third line operated on an underground system.

Provisional Orders.

The Highways Committee submitted the following report on this subject:—

We reported, on April 25th last, that the Board of Trade in granting the Blackheath and Greenwich District (Extension) Order had substantially adopted the amendments suggested by the Council, with the exception of those relating (*a*) to reduction in the standard price per unit, and (*b*) to the supply being by continuous current. With reference to the latter point, we asked the Board to reconsider its decision, in view of the fact that in the order granted in 1897 in respect of a district coterminus with that which is the subject of the present application by the same company, provision was made for the supply to be by continuous current. The Board has, however, intimated that after further consideration it is unable to adopt the suggestion. With regard to the first point, namely, a reduction of price, it will be remembered that the Council asked that in all orders granted this session the initial price might be reduced from 8d. to 6d. per Board of Trade unit. The Board, in reply to a letter sent by our direction since the orders were granted, has stated that it did not consider it desirable to adopt the suggestion in granting orders this session, but that it will consider any representations which the Council may make with respect to the reduction of the initial price in provisional orders applied for in future sessions. In the circumstances we do not think that the matter can, with advantage, be pressed further; but we will take care that the point shall be again raised with regard to orders which may be applied for next year.

It was decided to approve of a deviation from plans previously sanctioned for the erection of a generating station in Blackwall Lane, East Greenwich, so far as the extension of the engine house is concerned, on behalf of the Blackheath and Greenwich District Electric Light Company, and to refuse to approve plans for additions to two furnace chimney shafts at Stowage Wharf, Deptford, for the London Electric Supply Corporation, on the ground that it was not shown that each shaft was capable of receiving and sustaining the proposed superstructure.

Underground Electric Railways.

The following notice of motion stood in the name of Mr. Baker:—"That it be referred to the Highways Committee to investigate and report to the Council as to the practicability of constructing a shallow underground electric tramway from Westminster (*viâ* Parliament Street, Strand, Fleet Street and Cheapside) to the Bank, thence under Moorgate Street to the terminus of the North Metropolitan Tramways Company at Finsbury Pavement, on a similar principle to those laid under Andrassy Strasse, Buda-Pesth, and in Boston, U.S.A., provision being made beside the tramlines for suitable subways to contain gas and water mains, electric light mains, telephone wires, &c."

PARLIAMENTARY COMMITTEES.

Bermondsey Electric Lighting Bill.

Sir Henry Fletcher (Chairman) presided on Monday over a Select Committee of the House of Commons to consider the Bill confirming an electrical lighting provisional order for Bermondsey. Mr. Littler, Q.C., and Mr. Horace Avory were for the promoters, and Mr. Joseph Shaw appeared for the London Electric Supply Corporation, the petitioners against the Bill.

Mr. Littler, Q.C., in his opening statement, said the intention was to establish a dust destructor, and the Vestry considered it desirable to provide electric lighting within their district in order to utilise the heat generated by the destructor. The order was opposed by the London Electric Supply Corporation, a company which in bringing its electricity from its enormous works at Deptford to its metropolitan area passed through Bermondsey. In 1889 that company obtained power to supply electricity for lighting purposes in Bermondsey. As a matter of fact, the high tension alternating system was wholly useless for motive power purposes. There were a large number of manufacturers who would be very glad to secure a supply for trade purposes, and to meet this demand the Vestry proposed to provide a low-tension three-wire system. It was proposed by the Vestry to lay out for the purposes of the destructor something like £10,000, and in addition an expenditure on electric lighting works of £15,635 was contemplated. By this means it was thought the Vestry would be able to supply electricity for lighting purposes at a price equal to 1s. 9d. per 1,000 feet of gas—a figure so low as to be attained only in Newcastle and one or two other great coal centres. The net saving expected to result from the utilisation of the destructor would be £780 or £800 a year after paying all expenses and providing for the sinking fund, &c. In addition it was hoped the demand for light and power would give a reasonable return on the outlay on the electrical portion of the undertaking.

Mr. Edward Manville, electrical engineer, of 29, Great George Street, Westminster, a partner of the firm of Messrs. Kincaid, Waller & Manville, said he had acted as electrical adviser to the Vestry of Bermondsey, and he had advised them to adopt the three-wire low tension continuous current system. The London Electric Supply Corporation system in Bermondsey was on the high tension alternating current system transformed to a low tension system suitable for supply to their customers. Up to the time of a similar provisional order being before the House last year all the London Electric Supply Corporation had done besides laying trunk mains was to supply a very small portion of the parish indeed. Trunk mains passed through Bermondsey on the way to provide electricity for other parts of London. It had been almost invariably the practice of the Board of Trade to sanction two different systems in districts in London. He proposed an almost identical system in Bermondsey as that in Shoreditch, which was the first combination of a dust destructor with an electric lighting station. That combination had proved very successful in Shoreditch. His system would be available both for lighting and motive power. The County of London and Provincial Brush Electric Lighting Company had been refused an order to compete in Bermondsey. He had no doubt but that the Vestry would be able to supply light as cheaply as the company at present.

In cross-examination by Mr. Shaw, Witness said the only parish at present in which the local authority was competing with a company was in Newington, and that order was got with the consent of the London Electric Supply Company.

Mr. Hugh Mansfield Robinson, assistant clerk to the Shoreditch Vestry, gave evidence showing the success of the Shoreditch scheme.

Mr. L. J. Dunham, clerk to the Vestry of Newington, also supported the order.

Mr. Robt. S. Bain, the managing director of the London Electric Supply Corporation, said the company was practically started in 1887, and they lighted various parts of London by overhead wires.

Is it a fact that you have failed to fulfil your obligations in Bermondsey?—No.

First of all you put up enormous works at Deptford?—Yes.

And these works were put up, not only to supply electricity for Bermondsey, but for all the districts that you have got orders for?—Yes.

I believe you have had great difficulties with regard to the mains coming up from Deptford which caused you to get into difficulties and you had to raise money at debentures?—Yes.

But did these difficulties in any way interfere with your powers of distributing energy?—No.

Had you any difficulty about getting money for carrying on your works?—We had no difficulty at all.

When you got your order for Bermondsey did you start to work and find out if you could get customers?—Yes.

When you got the order did the Bermondsey Vestry consent?—Yes.

Proceeding, Witness said the company commenced canvassing for customers, and they put on a wiring firm to see if they could get the trade. He should say that Bermondsey was a much worse district for lighting by way of revenue than Shoreditch. They only got one customer from 1892 until the end of 1894, and they spent something like £600 on a main to run to that customer with the object of getting further revenue. In 1895 they laid something like 2,000 yards of mains, and in that year they managed to get 10 other customers. The Vestry had put great difficulties in the way of the company laying mains. They continually raised questions, and the company had continually to appeal to the Board of Trade.

How many customers have you got in Bermondsey now?—Up to the end of 1898 we had 17, and up to May 1st we got three others, a total of 22 altogether.

On the Committee resuming on Tuesday, Mr. Bain was cross-examined by Mr. Littler with a view to showing that the company had not opposed the Vestry getting an order at first, but had agreed to supply energy in bulk.

Replying to Mr. Compton Rickett (one of the committee) said that proportionately they had spent more on Bermondsey than any other parish. They were really the only company which had had experience of southern parishes. Many of these parishes had remained dormant for years, but suddenly a demand had sprung up, and in the case of Camberwell, Deptford and Newington, they found last year a very large demand. Had they known that the Newington Vestry had not intended taking current from them in bulk they would have strongly opposed the order.

You are afraid that you and the Bermondsey Vestry will divide the demand and neither will make it pay?—We think directly the pinch is felt the price will be brought down to such a figure that it won't pay, and the body with the longest purse will get the light.

Do you think the destructor will give the Vestry an advantage?—I think it is so little known at present that nothing can be founded upon it.

Further replying to Mr. Compton Rickett, Witness said that it was true that their mains at present were laying practically useless, but still it was hardly to be expected that they would sell those mains, because they had spent money with a view to reaping the benefit of the development of the district.

The Committee adjourned.

The Committee resumed on Wednesday, and after Mr. Shaw and Mr. Littler had addressed the Committee, the chairman, after a private deliberation, announced that they had decided to approve the preamble of the Bill.

LEGAL.

Cambridge Electric Supply Company *v.* Baily, Grundy and Barrett.

At the Cambridge Borough Police Court on Tuesday, Messrs. Baily, Grundy & Barrett, electrical engineers, of Cambridge, were summoned by the Cambridge Electric Supply Company for, on or about December 22nd, 1898, connecting a wire in Bridge Street with those of the company, without the latter's consent. There was a second summons in respect of the wires at Market Hill. Mr. J. E. L. Whitehead appeared for the Electric Supply Company, and the defendants were represented by Mr. St. John Raikes (instructed by Mr. Miller). Defendants pleaded not guilty.

Mr. Whitehead said the proceedings were taken under Section 18 of the Gas Works Clauses Act, 1897. In this case it seemed that the Cambridge Electric Supply Company had certain mains laid down in Bridge Street, and they laid mains leading therefrom to Mr. Nichols's house with a meter, and a wire leading from the meter to light the house. Subsequently Messrs. Baily, Grundy & Barrett were called in by Mr. Nichols to put in wires for additional lights for the house. The original wires, as far as the meter was concerned, were laid by the Supply Company. They alleged that the wires running at right angles from the street were their property.

Mr. Raikes said he was instructed that the Supply Company's wires were laid down by the defendant company, and all they did was to solder them to the main.

Mr. Whitehead said his case entirely depended upon the fact as to whether these wires, which were at right angles to the main, were the Supply Company's or not. If they were not, of course his case failed, because the defendants would not then have interfered with plaintiffs' wires. That was the crux of the whole thing.

Dr. Cooper: Do you say those wires are yours, Mr. Raikes; is that your contention?

Mr. Raikes: It is not my contention, sir; I say it is a fact.

John Henry Barker, engineer and secretary of the Cambridge Electric Supply Company, Limited, said the company's mains ran past the house, and witness knew that there were certain wires leading from the mains into the house. They were placed there in 1893, and were temporarily reconnected last year. To the best of his knowledge and belief the main and wires up to the meter were the property of the company. The meter, without doubt, was their property. On December 22nd of last year Mr. Nichols called at the company's office and made a communication to the clerk, and in consequence witness went to the premises the same day. He found a wire had been laid to communicate with a wire which was then, and is now, to the best of his belief, the property of his company. The new wire which he found laid was connected with the main leading to the meter, whereby it was possible for a current to be consumed without being registered by the meter. Witness had the wire removed on the same day.

Cross-examined by Mr. Raikes: Mr. Nichols made no application, but gave notice that he was going to put more light on. He was not aware of the receipt of the application until after December 22nd. Before Christmas the wire, which was improperly laid, was connected with the meter. He could not say whether there was a loop left on the wire for the purpose of connecting with the meter. No one had the right of connecting with the meter, or with the company's mains, except with the company's consent. If anyone had broken the seal of the meter to connect the wire to the body of the meter, that person would have committed the offence. It had once occurred that the contractors had carried wires as far as the main in the street, and the company paid for the wires, which then became the company's property. If the company had not paid for a wire of this sort, it would not become their property.

Mr. Raikes: I suggest that in this case these wires were laid by the defendants, and have not been paid for by you, and all that you have done was to solder them to the main.

Mr. Barker: That I can absolutely contradict, because there is a wire in Mr. Nichols's premises which I can prove is our property. In answer to further questions, witness said there were two wires from the main, and one went through the meter. There would be a "cut-out" between the meter and the street.

Mr. Raikes said his suggestion was that the wires terminating in the cut-out did not belong to the Supply Company. Unless the company could show the wires belonged to them they had no case.

Witness said they made no charge of robbery against the defendants, but he believed some current had been consumed and not registered by the meter.

George Ernest Nicholls, jeweller, of 57, Bridge Street, said in December of last year he had electric light on certain portions of his premises, and he gave an order to the defendants to add certain lights. They commenced work on December 17th and finished on 20th. On the 22nd he reported the matter to the Electric Supply Company.

Cross-examined: The men, when the work was finished, told him not to use the light, because the wire was not properly connected, and the current would not go through the meter. He only switched the current on for a moment to show his wife before the Supply Company made the connection.

Dr. Cooper (to Mr. Whitehead): Doesn't it all come to what evidence you rely upon as to whether this pipe, which was put down in 1893, is the property of the company?

Mr. Whitehead: Quite.

Dr. Cooper: What other evidence have you?

Mr. Whitehead: I did not know that the point would have been raised, and I have not got all the witnesses.

George Arnett, a wireman, 13, Richmond Terrace, in the employ of the plaintiff company, said in 1898 he put a new cable, altering

the number of volts, in Mr. Nichols's premises. The cable was supplied by the company.

Cross-examined: The new cable was connected with both the company's cut-out and the meter.

Re-examined: He had no doubt that the mains leading from the street to the meter were the property of the Electric Supply Company.

Mr. Raikes contended that in law, under the section, he had no case to answer at all. This section was made in respect of the person who caused the work to be done. It referred solely and entirely to the householder, and not at all to the people whom he employed. The section was aimed at those in position to obtain the company's consent, and the only person who could obtain that consent, according to the company's own orders, was the householder. He had a second point he wished to raise, and that was, that the conduct of the Supply Company acted as a waiver. They, on hearing that something which they believed to be irregular had been done, went to the house of the man for whose benefit it had been done, and, instead of taking an action of any sort, and saying, "You have laid yourself open to a penalty," they calmly complete the work, and he had no doubt had sent in their bill for it. Some days afterwards they approached a third party, namely, the agents who acted for Mr. Nichols, and said: "Look here, we are going to proceed against you at law." He said their completing the work acted as a waiver, and absolutely barred them from any right of proceeding against anybody.

Mr. Whitehead submitted that Mr. Nichols was in no sense an offending party. The section did not refer only to the consumer, but to every person who offended.

Dr. Cooper, after the magistrates had consulted, said they must overrule Mr. Raikes's point, but if he liked they would grant a case.

Arthur Barrett, managing director to the defendants, an electrical engineer, 6, Mortimer Road, said the defendant firm in 1893, at Mr. Nichols's cost, supplied the cut-out and the whole of the wires. The plaintiff company only supplied the meter. He had books to prove it. In December of last year his firm was again called in to instal five additional lamps. He examined the wires, which, to the best of his belief, were put in in 1893, and found that they had been soldered on to the mains. From the basement into the house the wires were the property of his firm.

Chas. Hy. Playfair, in the employ of Messrs. Baily, Grundy and Barrett, said in December of last year he was working on Mr. Nichols's premises. The cut-out there was similar to those his firm supplied, and the wires were also similar to those of the firm. Five additional lamps were put in, and he warned Mr. Nichols not to use the current until he had permission.

Mr. Raikes then addressed the magistrates. He said there was a great conflict of evidence, and this was a case in which it would be absolutely unsafe to convict, because on either hand they had witnesses of repute, men would not be likely to come there and make false statements, disagreeing with regard to certain matters. After dealing with the evidence, Mr. Raikes said it was clearly made out that the wires which were put in above the cut-out were put in connection with a wire which in turn was connected with the company's wire. As a matter of fact, the work was done absolutely honestly, not in contravention to the statute, and was not an act which deserved any punishment. He asked the magistrates to say that the case was not sufficiently made out.

The magistrates consulted in private, and on their return

Dr. Cooper said they had carefully considered the evidence, and found that an offence had been proved, communication having been made without the consent of the Supply Company. They fined the defendant company £1, in addition to £2 2s. advocates' fee, and the Court costs. If Mr. Raikes required a case they would grant him one on the question of law.

Mr. Raikes said he did, and would make his application in writing.

On the second case of a similar nature being called on, Mr. Whitehead said he had a statement to make, which he hoped would be satisfactory to the magistrates, in that it would save the time of the Court. The object of the Electric Supply Company was not a vindictive one; all they wanted was that in the future their mains should not be interfered with. Practically, therefore, they had got what they wanted—they had got a conviction against the defendant company which showed to the public generally that they had no right to interfere with the company's mains. Under the circumstances, they did not propose to proceed with the second case, but would ask to be allowed to withdraw it.

Mr. Raikes said, considering their position, they felt their action had been to a certain extent justified by what had occurred that day. It had been shown there was no attempt to defraud the Supply Company or to deal unfairly with the company in any way. They admitted in the first case that so far as the Court's finding was concerned, they had made a mistake, and in acceding to the application to withdraw the second case, his clients felt it would be saving the time of all concerned, and perhaps any future expense in the matter.

The Metropolitan Electric Supply Company, Limited, *v.* The Vestry of the Parish of St. Marylebone.

This case came before Mr. Justice Byrne in the Chancery Division on Wednesday, on a motion by the plaintiffs, the Metropolitan Electric Supply Company, for an injunction to restrain the defendants from interfering with certain wires or electric cables laid beneath certain streets in the Marylebone parish.

Mr. Cripps, Q.C., who appeared with Mr. Sergant for the plaintiff company, said that the matter was a very important one, because if his clients were held to be in the wrong, they would not be able under their statutory obligations to supply the district which they had undertaken to supply with electric light. The matter in issue depended upon the construction of certain Acts of Parliament, there being no dispute as to the facts. The learned counsel stated that the plaintiff company last year obtained Parliamentary powers to erect a large generating station and works at Willesden, from which current could be supplied from the plaintiff company. The plaintiffs' area of supply comprised Paddington, Marylebone, and the Strand and Holborn districts. The present question arose in this way. At a certain point in the Edgware Road the Paddington district ended, and the Marylebone district began. The plaintiffs wishing to lay their wires along Dorset and South Streets at the end of the Marylebone district, served on the defendants the usual notice, which was in accordance with the terms of the Act of Parliament. When the plaintiffs came to carrying the works through the Edgware Road in the Marylebone direction, the defendants sent certain men who interfered with the plaintiffs doing the work. He (counsel) might say at once that a similar question arose between the company and the Paddington Vestry, which was to have been argued on Tuesday before Mr. Justice Phillimore, but the parties in that case hoped to come to an amicable arrangement and so get rid of the necessity of discussing the legal question, and consented to an adjournment on the electrical company giving an undertaking.

His Lordship: Is there no likelihood of anything of the sort in the present case?

Mr. Cripps was afraid not. The defendants by their defence said that the company had no statutory power to break up the streets at all; and, secondly, that such a proceeding was inconsistent with the terms of an agreement entered into between the plaintiff company and the Vestry. The defendants also contended that the notice served upon them by the company was insufficient. This latter point was one more for the Board of Trade than for his Lordship. The learned counsel then referred his Lordship to the company's provisional order, and to the Electric Lighting Act, 1882, Section 12, Sub-section 2, which enacted that the provisions of Section 6 of the Gas Works Clauses Act, 1847, with respect to the breaking up of streets for the purpose of laying pipes should be incorporated and be applicable to electric lighting. There was power for the gas company in that Section to do such work as was "deemed necessary for the supply of gas to the inhabitants of the district included within the said limits," the company doing as little damage as possible and making compensation for any damage done during the execution of the work, and so on. What the plaintiffs said in the present case was that the work they wished to do was in their opinion necessary for the purpose of supplying electric light to the inhabitants of the district "included within the limits." His Lordship was aware that it was found to be a nuisance to erect a large generating station in a crowded neighbourhood, and an Act was passed giving companies power to erect them outside their area of supply. The plaintiffs obtained powers to construct their works at Willesden, and if the defendants were right in their contention the result would be that having constructed their generating station outside the area of supply and they were stopped from bringing their current within the area of supply, their generating station would be useless and they would be deprived of the right to which they were entitled. If the plaintiffs could not get the extra current from the Willesden works they would not be able to meet the supply to the inhabitants in their area of supply next winter.

After some further discussion it was arranged that the case should stand over, the defendants agreeing to allow the plaintiffs to proceed with their works on the plaintiffs undertaking to remove the cable and restore the streets, if it should be decided that they are not entitled to lay the cable, and in the same terms as the undertaking recently given by the plaintiffs to the Paddington Vestry. The motion to stand over generally with liberty to either party to bring it on upon two days' notice.

The Vestry of Paddington *v.* The Metropolitan Electric Supply Company, Limited.

Mr. Justice Phillimore had this case before him in the Queen's Bench Division on an adjourned summons last Tuesday.

Mr. A. T. Lawrance, Q.C., and the Hon. Alfred Lyttelton appeared for the plaintiffs; and Mr. Cripps, Q.C., and Mr. Sergant for the defendants.

When the case was called on, Mr. Lawrance stated that he and his learned friend, Mr. Cripps, were of opinion that if his Lordship would grant an adjournment there was every possibility of the parties coming to an arrangement. If it were necessary that the case should go on it would take some time to argue as the question to be decided was one of some complication. Mr. Cripps, on behalf of his clients, was willing if the adjournment were granted to continue the undertaking he had already given.

His Lordship: There is no undertaking as yet before me.

Mr. Lawrance said that his learned friend had given an undertaking that if his clients were allowed to go on with their work, they would, in the event of the Vestry succeeding, make restoration.

His Lordship said that the Court of Appeal had decided that an injunction in such a case could not be granted, as the Vestry had no right to land under the street.

Mr. Cripps agreed that this was so. It was very desirable that an arrangement should be come to between two public bodies, and he thought it would be. It was essential for the defendants to go on with their work, because [if they did not they would be unable to supply their customers in the winter. He was willing, however to give an undertaking that in the event of an adverse decision against the defendants being given, any work carried out by them subsequently

to the return of the summons should be removed to the satisfaction of the Vestry.

His Lordship said it seemed he had better order the case to stand over generally.

Mr. Lawrance: Yes, we can always bring it on by mentioning it.

His Lordship: Yes, by asking the Judge in Chambers.

Mr. Cripps: I should think it had better come before your Lordship as you have had it before.

His Lordship: Well, in all probability I shall be going to the Western Circuit next sittings, so it must be subject to that.

Mr. Lawrance: We will argue it before your Lordship if you can give us a day; if not, we must go before the Judge in Chambers.

The case was eventually ordered to stand over generally on the defendants giving an undertaking in the terms stated.

Tudors, Mash & Co., *v.* Headland's Patent Electric Storage Battery Company, Limited, and Walkers, Parkers & Co., (Third Parties).

This case came before Mr. Justice Mathew sitting without a jury in the Q. B. Divison, on Monday, Tuesday and Wednesday last. It was an action brought by the plaintiffs against the defendants, the Headlands Patent Electric Storage Battery Company, Limited, to recover £75 6s. 6d. for goods sold, viz., red lead and litharge, between October and December, 1897. The defendants admitted the plaintiffs' claim as set out in the statement of claim, but by way of set off or counterclaim, they said that the goods which they ordered of and received from the plaintiffs consisted of eight casks of red lead and ten casks of powdered litharge, and that the plaintiffs well knew that the litharge was to be used for the purpose of making electric storage batteries, and was to be pure and of the best quality. They alleged that the litharge supplied by the plaintiffs was found to be of inferior quality, defective, impure, and unfit for the purpose for which it was sold by the plaintiffs, whereby a large number of plates for electric storage batteries, packed with the litharge and red lead, were spoiled and rendered useless. The defendants pleaded that by reason of the plaintiffs' alleged breach of contract they had suffered special damage, and claimed on this head £500 10s. 8d. The defendants further alleged that the litharge contained lime and foreign matter, including a small quantity of iron, to an extent which averaged between 8 and 9 per cent., and of this about 5½ per cent. was carboric acid, the carbonic acid being present mainly in combination with lead as carbonate of lead. The plaintiffs, by way of defence to the counterclaim, denied that they had any knowledge of the purpose for which the litharge supplied by them was intended to be used by the defendants, or that they undertook to supply litharge which should be fit for the purposes alleged. They said they only undertook to supply, and did supply to the defendants, genuine powdered litharge of the usual quality supplied by them to the defendants for several years past. They also denied that the litharge supplied by them to the defendants was of inferior quality, or was defective or impure, or that it was supplied by them to the defendants to be used for any of the purposes stated. They also denied that the defendants had been indemnified as alleged. The plaintiffs served upon Messrs. Walkers, Parkers & Co., the firm from whom they had purchased the litharge sold to the defendants, a "third party" notice claiming to be indemnified by such third parties in respect of any breach of their contract with the defendants. The third parties alleged that they did know for what purpose the litharge sold by them to the plaintiffs was to be used. Nor did the plaintiffs inform them. They further said that they supplied to the plaintiffs powdered litharge of the usual mercantile quality in accordance with the terms of the plaintiffs' orders. They also further said that the litharge supplied by them to the plaintiffs was pure, and of the best quality, and that the plaintiffs were not entitled to be indemnified by them for any damages they might be put to by reason of breach of contract, or otherwise.

Mr. Fletcher Moulton, Q.C., and Mr. Peile appeared for the plaintiffs, Mr. O'Connor, Q.C., and Mr. Eldredge for the defendants, and Mr. Robson, Q.C., and Mr. Haldonstein for the third parties.

At the conclusion of the evidence and the arguments of counsel, his Lordship reserved judgment.

Alexander *v.* The Automatic Telephone Company, Limited.

In the Chancery Division of the High Court of Justice, on the 12th inst., Mr. Justice Cozens-Hardy concluded the hearing of this action, which was brought by Messrs. M. J. Alexander and J. D. Gibbs, suing on behalf of themselves and all other shareholders in the defendant company, against the company and three of its directors, viz., Messrs. Max Margowski, J. Woolf Cohen, and H. G. Sworn. The other members of the board were the two plaintiffs. The defendant company was incorporated in June, 1897, with a capital of £100,000 in shares of 5s. each. The signatories to the memorandum of association were Margowski, for 19,400 shares, and as managing director of the Honduras Government Banking and Trading Company, Limted. for 6,000 shares; the plaintiff, Alexander, for 10 shares; the plaintiff, Gibbs, for 10 shares; Justin Mendelson, for 10 shares; and the defendant, Sworn, for 500 shares. The memorandum shares and a number of other shares were allotted, and on all of them, except those held by Margowski, Cohen, Sworn, and the Honduras Company, the sum of 3s., payable on allotment, had been paid. In respect of the excepted shares, the plaintiffs alleged that only £784 in all had been paid, and that on these shares there was still due and payable the sum of £3,176, and the plaintiffs complained that the three defendant directors, being a majority of the board, were able to and did control its action by their votes, and in breach of their duty as directors, and against the interest of the defendant company prevented the passing of resolutions or taking steps to enforce payment by such defendants or the Honduras Company (in which they were said to be interested) of the amounts due on their shares and the shares held by the Honduras Company. The plaintiffs alleged, however, that this did not prevent the defendant directors, by means of their voting power, making a further call of 1s. per share, and their case was that the defendant directors were acting in furtherance of their own interest, and in fraud of the rights of the other shareholders, and were using the powers entrusted to them as directors for their own ends, and not for the benefit of the company. The plaintiffs accordingly asked for a declaration that the holders of the memorandum shares were bound to pay up 3s. per share like the holders of the other shares. For the defence it was pleaded that on June 30th, 1897, before the company was incorporated, it was agreed at a meeting of the signatories that nothing should be payable by any of the defendant directors or the Honduras Company on application or allotment in respect of their memorandum shares, and that the memorandum was signed on this condition; that at a board meeting on July 5th, 1897, two resolutions were passed (both the plaintiffs being present and voting in their favour) for the allotment of shares: that by the first resolution memorandum shares were allotted without requiring any payment or allotment, and that by the second resolution a payment of 2s. 6d. per share in respect of other shares was required on allotment. The defendant directors also said that they were acting under the articles, and in the interests of the company and had committed no breach of duty. In the result Mr. Justice Cozens-Hardy came to the conclusion that the plaintiffs had not made out their case. He said it was an attempt to make members of the company pay for shares otherwise than in accordance with the articles. He thought that the whole action failed and must be dismissed with costs. Mr. Eve, Q.C., Mr. Rawlinson, Q.C., and Mr. H. Dobb appeared for the plaintiffs; Mr. Rufus Isaacs, Q.C., Mr. Stokes, and the Hon. Frank Russell for the company and Margowski; Mr. H. P. Chapman for the defendant, Cohen; and Mr. Astbury, Q.C., and Mr. Hamilton for the defendant, Sworn.

Harten *v.* Dublin Southern Districts Tramways Company.

At Dublin on Monday, in the Queen's Bench Division, this motion was heard for a new trial of the action. The action was brought by the plaintiff, who resides and carries on business in George's Street, Kingstown, to recover damages from the defendants for having altered and lowered the level of the street in front of his premises while laying the new electric tramlines, and so injuring and obstructing him in the business and interfering with his customers. The defendants pleaded that what they had done they had done by virtue of powers legally and duly obtained by them for the purpose, and they denied the acts complained of, and that the plaintiff had suffered any damage. On the trial of the action the jury found a verdict for £666 for the plaintiff. When the Court adjourned the arguments were not yet concluded.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week ending May 17th, 1898.		Week ending May 16th, 1899.	
Berbice	Value £11	Adelaide	Value £283
Beira. Teleg. mat.	373	Alexandria	183
Bilbao. Teleg. mat.	400	Amsterdam	12
Bombay	78	Beyrout	50
Boulogne	110	Bombay	182
Brisbane	40	Bordeaux	72
Buenos Ayres	380	Boulogne	164
,, Teleg. mat. ..	65	Buenos Ayres	210
Calcutta	74	,, Teleg. mat. ..	431
Cape Town	846	Calcutta	445
Copenhagen	15	Cape Town	1,036
Demerara	42	Christchurch	146
Durban	428	Colombo	156
Flushing	36	,, Teleg. cable	85
Fremantle	39	Delagoa Bay	34
Lisbon	2,910	Durban	546
Madras	9	East London	605
Melbourne. Teleg. mat. ..	170	Gibraltar	41
New York. Teleg. mat. ..	532	Grenada	17
North Atlantic. Teleg. cable ..	11,520	Hamburg	200
Novorossisk	23	Jersey and Guernsey	421
Penang. Teleg. mat	856	Malta	14
Port Elizabeth	250	Melbourne	281
Shanghai	393	Odessa	200
Singapore	466	Oporto	6
St. Petersburg	200	Otago	173
Sydney	44	Penang	21
Teneriffe	19	Piræus	800
Townsville	14	Port Chalmers	283
Wellington	124	Port Elizabeth	220
Yokohama	43	Rio Janeiro. Teleg. mat. ..	13
,, Teleg. mat.	99	Santos. Teleg. mat.	100
		Shanghai. Teleg. mat.	4,710
		Singapore	80
		St. Petersburg	102
		Sydney	497
		Tientsin. Teleg. mat.	262
		Vigo. Teleg. mat.	253
		Wellington	144
		Yokohama	93
Total ..	£19,516	Total ..	£13,099

Foreign Goods Transhipped.

Syracuse £105

Book Received.—Annual Report of the Smithsonian Institution, 1897. Washington City, 1898.

British Insulated Wire Company.—The directors of the British Insulated Wire Company, Limited, announce that in view of the growth of the company's business, the output for the first four months of 1899 showing an increase of £80,000 in value over that of the corresponding period of 1898, and the company having now on its books orders to the amount of more than £300,000, they have decided to issue the 12,500 6 per cent. cumulative preference shares of £5 each, which form the part of the authorised capital still remaining unissued. The issue will be strictly confined to existing preference and ordinary shareholders, and will be allotted at a premium of £1, and in the proportion of one new share for every 5⅔ths now held. Dividends on the shares of this issue will commence to accrue from July 1st next.

Brussels Electrical Exhibition.—This Exhibition will not be opened till June 3rd instead of June 1st as hitherto stated, owing to His Royal Highness Prince Albert being unable to attend on that day, he having to open an Industrial Exhibition in Ghent on June 1st. English exhibitors are requested to make immediate application to the secretary for a document (if they have not already received one) to be filled up with particulars of their exhibits, so as to enable the goods to enter Belgium free of duty with half cost for carriage on the State Railway in Belgium. They are also requested to forward their goods as soon as possible as it is desired to have everything complete on the opening day.

Lists.—Messrs. Allan & Adamson, Limited, send us illustrated price lists of several types of the "Allan" accumulators.

Change of Address.—Messrs. Venner & Co. have removed from 10, Delahay Street, to 6, Old Queen Street, Westminster, S.W., where all future communications should be sent.

Charge.—At the Guildhall on Saturday, Herbert Adams, electrician, was charged on a warrant with conspiring with a man named Owen (not in custody) to obtain, by means of false pretences, of Mr. J. Phibbs, clerk in the service of a firm of French manufacturers having offices in the Wool Exchange, a quantity of cable, &c., to the value of £114. The information on which the warrant was obtained having been read, the prisoner was remanded.

Electric Power in Shipbuilding.—The Sunderland Forge and Engineering Company, Limited, who are now engaged in fitting a very complete equipment of electrical power plant at the works of Messrs. S. P. Austin & Sons, have also received an order from Messrs. John Priestman & Co., to fit their extensive shipbuilding premises at Castletown with a similar equipment of electric motors for machine driving purposes.

Electric Swing Bridge at Northwich.—On Sunday last, the electrical machinery for actuating the wedges and turning the navigation swing bridge erected on the river Weaver at Northwich by the Weaver Trustees, was tested with satisfactory results. This is the first instance in Great Britain of a swing bridge being worked by electric power. The bridge itself is entirely novel, and is partially water-borne on a circular pontoon. Another bridge in *fac simile* is being erected in place of the old Northwich town bridge.

Electrical Illumination.—H.R.H. the Duke of York honoured Messrs. Cooper's new Exhibition Tableaux Lumières et Decoration Electrique, at their Galleries, in Great Pulteney Street, W., with a visit on Tuesday afternoon.

Electrical Wiring Prices.—A meeting of electrical engineers was held on 12th inst. at the Hotel Métropole, Foster Square, Bradford. Mr. A. J. Harris presided, and there were present Messrs. Frank Little and H. Addison (representing the National Wiring Company, Limited), Messrs. Rhodes and Webster, Mr. Collinson (Messrs. Collinson Bros.), Messrs. H. Meyers and J. N. Atkinson (Messrs. A. J. Harris & Co). Apologies for absence were sent by Messrs. Ullathorne, Davies and Barnes. Mr. Harris explained that the meeting was called to discuss the present unremunerative prices for electrical wiring, and, if possible, to adopt a standard rate of wages for practical wiremen. He proposed that the minimum rate for wiring from the Corporation mains should be 15s. per light. An animated discussion ensued, and it was eventually decided, on the motion of Mr. F. Little, to adjourn the meeting to a date to be fixed subsequently, when representatives of other firms interested and a representative of the Electrical Trades Union could be present.

E.P.S. Batteries.—We recently stated that the Bradford Corporation had given the contract for the storage battery lately advertised for to the Tudor Accumulator Company. We, however, understand that the Electrical Power Storage Company have received an intimation that their tender has been accepted for installing a battery of similar type to those which they have already supplied to the Liverpool Corporation for their trams, and to the Metropolitan Electric Supply Company for their two stations.

Fires.—A short circuit of electric wires caused an outbreak of fire on Friday last at the electric storage and battery works of the Headlands Company, Limited, 17A, Allington Street, S.W. The switchboard in the storage room, on the ground floor, burst into flames, and much damage was caused before the mischief was overcome.

The other evening a fire occurred on the property of the London Electric Supply Corporation, Limited, in a railway arch under the South-Eastern Railway in Southwark Park Road. A short circuit of electric wires resulted in the ignition of a switch box and a quantity of fittings.

Liquidations, Dissolutions, &c. — Creditors of the Yorkshire House-to-House Company must send particulars of debts, &c., to the liquidator (Mr. Grosvenor Talbot, 1, Whitehall Road, Leeds) by June 24th.

The Electric Organ Company, on May 5th, resolved to wind up voluntarily and appointed Mr. A. Foxworthy, liquidator.

Messrs. J. R. Lee and J. McDonald (Lee & McDonald, electrical engineers, Canning Place, Liverpool) have dissolved partnership. Debts will be attended to by Mr. J. McDonald.

The Midland Electric Power Scheme.—On Tuesday, in the House of Commons, leave was given to introduce a Bill to confirm a provisional order relating to the extension of the area of supply of the Midland Electric Corporation for Power Distribution, Limited.

Personal.—Mr. A. A. Campbell Swinton has joined the board of the Cambridge Electric Supply Company, Limited.

Mr. H. F. Parshall announces that on and after May 24th, his offices will be removed to 8, Princes Street, Bank, E.C., where all communications must be addressed.

Mr. C. W. S. Crawley has acquired an office at Princes Mews, Gt. George Street, Westminster, where all communications should be addressed.

Preston Electric Company v. Sampson.—At the Birmingham County Court last week the plaintiffs sued defendant who was manager of the Metropolitan Bank, to recover £59 for electric lighting work done. Counsel explained that the defendant had a private residence at Hampton-in-Arden, and in 1896 he employed Mr. George Wright Preston to put in an installation of the electric light. Preston subsequently converted his business into a limited company. The work was done and the total of the bill came to £139, but of this defendant had paid £80, and the action was brought to recover the balance. Plaintiff gave evidence of the performance of the work. Before he concluded, however, the Judge suggested that Mr. Frederick Brown, who had been appointed by the Court at the request of the parties to value the work, should be called. This witness, estimating on the basis of an open contract, valued the work at £95. His Honour suggested a settlement on this basis, but it was not accepted, and plaintiff resumed his evidence. He denied in cross-examination that the dynamo which was put in was not capable of fulfilling the defendant's requirements. He was also questioned as to his charges being excessive. The defendant said that when the machinery was first started they could not get sufficient current to charge the accumulator. The dynamo should have done this in ten hours, but they had to run it continuously for three days and nights. The engine should have run at 1,660 revs. to properly work the dynamo, but at that speed it had no effect. They increased it to 2,000 and produced current, but it was at the expense of heating the bearings. Plaintiff suggested a larger engine, and on this being put in it simply caused the dynamo to burn out. It set the armature alight, and he had to get another dynamo at a cost of £45. Apart from what he had paid plaintiff, the installation had cost him about £200. Cross-examined: There was not a fixed amount for doing the work, but he did not object to paying for it at its proper value. The Judge said he did not think that plaintiff had proved any sufficient reason to alter the expert's figures, and therefore he gave judgment for the plaintiff for £15.

Trade Announcements.—The Ivry Electric Glow Lamp Company inform us that Messrs. Downie & Adams are no longer their agent in the United Kingdom, and that from May 1st they have opened a branch of their own at Connaught Mansions, 34, Victoria Street, S.W., where they keep a large stock of their well-known high voltage and ordinary lamps. All future communications should be sent there.

Messrs. Nalder Bros. & Co., Limited, inform us that Messrs. Muirhead & Co., of Princes Mews, Great George Street, Westminster, have acquired the testing and scientific instrument branch of their business, and have taken over the whole of their electrical standards, drawings, test room plant, &c., as well as their test room assistants. Messrs. Muirhead & Co. have engaged their works' manager, Mr. C. F. Wilkins, and have also made arrangements with Mr. C. W. S. Crawley, under which he will give advice on any matters regarding Nalder's specialities that may be submitted to him. The continuity of the business will thus remain unimpaired.

Messrs. H. T. Boothroyd & Co., electrical and mechanical engineers, &c, of Bootle, who in January purchased the electrical engineering business of Messrs. W. & J. Robinson & Co., have now removed to their new and specially built premises at Arkenside Street, Bootle, which are equipped with the most modern machinery and tools for economical and prompt execution of work. Several direct-coupled ship lighting plants, &c., are kept in stock.

Mr. H. T. Sully has started in Bristol as electrical and mechanical consulting engineer, at 1, Queen Anne Buildings, Bristol, having given up his business as contractor.

Messrs. Welch & Fry, electrical engineers, are shortly removing from No. 113, London Wall, E.C., to No. 90 in the same thoroughfare.

Messrs. J. & A. Anderson, of 62, Robertson Street, Glasgow, have recently been appointed agents for Scotland for the sale of cables and wires for electric purposes, on behalf of Mr. I. Frankenburg, cable manufacturer, of Salford.

The Vesuvian Insulator Company, who are manufacturers of all kinds of moulded insulators and line material for electric tramways, have opened a branch at Connaught Mansions, 34, Victoria Street, S.W. We understand that their material is largely used by tramway constructors on the Continent.

The Concentric and General Contract Company (Messrs. J. A. Cross and W. Mossop) have commenced business at 52, Queen Victoria Street, E.C., for carrying out general contracts relating to the supply

and distribution of electricity. A special feature will be made of the J. D. F. Andrews concentric system, and the firm will also introduce, where suitable, a system in which twin wires will be used, both conductors being insulated and protected by iron armouring.

ELECTRIC LIGHTING NOTES.

Ambleside.—The agreement between the District Council and the Windermere Electricity Company has been prepared and is now with Mr. Hopkinson, the engineer.

Blackburn.—The paragraph headed Longton last week should have appeared under Blackburn.

Bolton.—The Gas and Lighting Committee last Friday approved of a report on street lighting prepared by Mr. William Smith, gas engineer, and Mr. James Parker, lighting superintendent. These officials were requested to undertake this task consequent upon a communication which was received from the Electricity Committee suggesting electric arc lighting for the principal streets in the town. Generally speaking, the report is unfavourable to the general introduction of the electric light, but as far as one can judge, the objection is based entirely on the question of the increased cost which would be entailed by the change. The officials named say:—"As instructed by the Committee, we visited Southport and Liverpool to see the street lighting in those towns, and as Liverpool is a commercial city, more like Bolton than Southport, we purpose to report on what we saw there, both as to the light and cost of same. In the first place, we may mention that the Corporation of Liverpool are the proprietors of the electric light works, whilst the gas works belong to a private company. The Corporation have introduced electric arc lighting into several streets; they have fitted up 133 arc lamps of 600 candle-power nominal, the lamps being placed 50 yards apart; 3d. per unit is charged for the current, and, in addition, the annual maintenance charge amounts to £3 19s. 4d. per lamp. The town is lighted principally by single and double incandescent gas lamps, which gave a very fine light. These incandescent lamps are placed 40 yards apart, on each side of the street or road, and give all the light that is required. We consider this mode of lighting to be preferable to electricity, as the lights are not so far apart, and the light is nearly equal over all the street or road. We consider that the main factor in street lighting is to have the streets well lighted at as low a cost as possible. The Corporation of Liverpool find that they can light their streets well at a much less cost by incandescent gas lamps than they can by electricity, and hence they are extending this mode of lighting over the whole town. At present they have 4,000 of these lamps in use, and extending rapidly. The cost of lighting by electricity they find to be £750 per mile, with lamps 50 yards apart, on one side of road only, or in the centre of the road if found convenient; by double incandescent gas lamps, £127 per mile; for single incandescent gas lamps, £89 per mile; and for ordinary gas lamps, £81 per mile, all being placed 50 yards apart, the same as the arc lamps. Seeing that the annual cost of lighting the streets with electricity in Liverpool is six times greater than that of gas, the lamps being placed the same distance apart, and bearing in mind the fact that the Lighting Committee of the Liverpool Corporation have decided to light the whole of the city with incandescent gas lamps during the next four years, there can be no doubt as to their opinion as to the most economical and satisfactory system. In the case of Bolton the arc lamps were to be fixed 80 yards apart, and after midnight 160 yards apart, as compared with Liverpool being only 50 yards apart. In our opinion this would not light the town in a satisfactory manner, nor nearly so well as it would be by single and double incandescent gas lamps placed along the streets or roads, say, 20 to 30 yards apart." The report then goes on to show that to light certain streets in Bolton, as proposed by the Electricity Committee, the cost would be £900 per annum, and if placed as in Liverpool £1,440, with one half the lamps extinguished at midnight; whilst for incandescent gas lamps on both sides of the streets 40 yards apart, the cost would only be £566 5s. per annum. This would allow of 200 lamps being lighted the whole night through. They are of opinion, however, that to light the town properly, the incandescent lamps should be placed, say, 20 yards apart and the electric lamps 50 yards apart. If the lighting of the streets in this way were adopted, the cost would be as follows:—Double incandescent gas lamps, 20 yards apart, would cost per mile £320 2s.; single incandescent gas lamps, 20 yards apart, would cost £225 2s. 8d. per mile; arc lamps, 50 yards apart, and maintenance as at Liverpool, £750.

The Electricity Committee of the Bolton Corporation at its meeting on Friday last resolved that the sum of £1,000 should be handed over out of the year's profits in aid of the rates. This is the first time the Committee has been in a position to do this, because, up to last year, when £306 16s. 2d. was placed to reserve fund, the whole of the profits earned were swallowed up in the repayment of loans and interest on same. The gross profits on the working of the financial year ending March 31st last amounted to £4,536 3s. 2d. as against £3,160 7s. 7d. in the preceding 12 months. Of this, £1,598 15s. 5d. was absorbed by interest on loans, and £1,731 13s. 3d. in repayment of loans, the balance of £1,205 14s. 6d. The total income was £7,942 6s., made up as follows:—By sale of electricity (less discounts, £700 15s. 3d.), £6,987 2s. 3d.; rental of hired meters (less 5s. 2d. for allowances), £219 0s. 11d.; and electric fittings trade, £736 2s. 10d. The fittings sold and work done represented £6,526 2s. 1d., whilst the cost in wages, for materials, and for interest on capital, aggregated £5,789 19s. 3d. The total expenditure for the year was £3,406 2s. 10d. as against £2,922 in the previous year, the principal items being as under:—To generation of electricity (salaries, fuel, &c.), £2,389 13s. 9d.; repairs of mains, fuses, &c., £70 13s. 1d.; management expenses account, £602 £18s. 11d.; rents, rates, and taxes £248 15s. 6d., and deputation expenses £51 17s. 11d. Bad debts are represented by £14 9s. 6d. In the account showing liabilities and assets there is a surplus of £5,660 8s. 4d. in favour of the Department. The expenditure on works since their commencement in 1895 amounts to £67,252 12s. 5d. The total Board of Trade units generated was 560,375 as against 486,836 last year, and of this 427,875 were accounted for; unaccounted for 132,500, or 23·64 per cent. compared with 27·00 per cent. in 1898, 29·73 in 1897, and 31·34 for 1893. The total length of mains laid is 50,870, and the number of consumers 559, as against 34,750 and 390 respectively in 1898.

Bootle.—Last week the Watch Committee recommended that application be made for borrowing further sums for the purposes of electric lighting and traction, and this was passed by the Council, but an amendment was also carried instructing the Committee "that no further expenditure in connection with the lighting by means of electricity in the public thoroughfares be authorised until a report has been presented to, and discussed by, the Council, showing (1) the amount already expended on street lighting by electricity, together with an estimate of the annual cost of the same; (2) the cost of lighting the same area with gas during the previous twelvemonth; (3) the cost of lighting the same area by incandescent gas, on the lines of the system adopted by the Lighting Committee of the city of Liverpool."

Bradford.—The City Council has adopted the recommendation of the Gas and Electricity Supply Committee that the price of electricity for power should be reduced to constant users to 1d. per unit, and to intermittent users to 2d. per unit.

Bromsgrove.—A communication from the English Industrial Company, offering terms for lighting the district by electricity, has been referred to the Lighting Committee.

Carlisle.—The public inauguration of the electric light installation was to take place last week.

Chatham.—The Council has given the contract for the electric wiring of the Town Hall to Messrs. Stevens & Barker.

Chester.—The electric light accounts for the year ended March 25th last have been completed, being the second full year of working. There is a balance of £4,611, with which it is proposed to deal as follows:—To interest on capital expended, £1,441; sinking fund, £1,317; preliminary expenses written off (balance) £1,052; reserve fund, £800.

Chesterfield.—The Electrical Energy Committee recently considered the report, plans, and estimates of the Westinghouse Company on the proposed supply of electricity for public and private purposes. Also Messrs. Davies & Co.'s letter on the subject of supplying electricity. The further consideration of the question was deferred.

Clerkenwell.—At the last Vestry meeting a report was brought up from the Electric Lighting Committee, which did not propose to go to Parliament for powers at present to light the parish by electricity.

Colwyn Bay.—Mr. S. V. Clirehugh recently reported to the Council upon his examination of the existing building adjoining the generating station, by which it was shown to be inadvisable to erect permanent buildings unless a larger sum was expended. Plans showing provision which would meet the demand for electricity during the next 10 years were submitted together with a tracing of the temporary buildings and plant which would not exceed the amount previously named. Mr. Clirehugh was instructed to complete the drawings and estimates for the Local Goverment Board in accordance with the tracing No. 400, *i.e.*, the erection of a temporary building having an iron chimney 80 feet and a diameter of 4 feet 6 inches.

Consett.—The Urban District Council last week discussed the question of incandescent gas *v.* electricity. An experiment with the former has been satisfactory, and is to be continued. One speaker drew attention to the question of combining refuse destructors with an electric lighting installation. The Lighting Committee has had the matter of electric lighting under consideration, and deferred it while waiting for certain plans which were being prepared. The whole subject will be further gone into by the committee shortly.

Cromer.—The Highways Committee has met Mr. Cozens-Hardy (Messrs. O'Gorman & Cozens-Hardy) and consulted him as to the establishment of electric light works, and also considered the replies which had been received from various towns. The Committee postponed action until the next meeting of the Committee, and resolved that in the meantime a digest of the replies be prepared and that Mr. Cozens-Hardy be required to furnish a further report. Also that notices be sent to householders in the district inquiring whether they would take a supply of electricity in the event of works being established, and that negotiations be entered into with the Cromer Hall trustees for a site.

Croydon.—The Croydon County Council on Monday considered a report on the electrical undertaking which has now completed its first year's history as a municipal undertaking. The Lighting and Electricity Committee reported that the accounts of the year's working showed a gross profit on the year of £5,340. Of this sum £4,092 2s. 8d. had been transferred in payment of interest and sinking fund on loans, leaving a balance of net revenue for the

year of £1,247 17s. 4d. In consequence of the refusal of the Local Government Board to sanction a loan for the payment of the premium to the British Thomson-Houston Company, £1,000 had been allocated to pay off this sum, leaving a balance of £247 17s. 4d. to carry forward to next year's account. The committee pointed out that a considerable portion of the works on which capital had been expended during the year, and on which sinking fund and interest had been paid during the same period, had not during the year been fully productive. In some cases, for instance, cables had just been laid for extensions which were included in the capital expenditure of the year, but the full revenue which might be expected from connections to these cables would not be received until the current year. The committee referred also to a report presented by them in December, in which they recommended the adoption of the principle involved in the "maximum demand system" of charges for the electric light, which principle the Council then adopted. The committee now recommended that the charge for current be made, at the option of the consumer, on the maximum demand system at the price of 7d. a unit for the first hour's average demand, and 2d. a unit for the remainder of the supply. The Council adopted the committee's report and recommendation.

Derby.—The Board of Guardians on Tuesday resolved to light the poor law offices and buildings with electricity.

Doncaster.—The Electricity Committee has recommended that an electrical engineer, to act as clerk of the works, with the prospect of becoming the resident engineer if satisfactory, be at once advertised for.

Douglas (I.O.M.).—The Town Council had a long discussion last week regarding the recommendations of the Electric Lighting Committee. Prof. Fleming's appointment to act as engineer to the Council in establishing an electrical undertaking was confirmed.

Droylsden.—The *London Gazette* contains notice of the transfer of the District Council's provisional order to the Manchester Corporation.

Dunkalk.—The Tramways Syndicate having delayed to accept the terms offered by the Town Council for the transfer of the electric lighting license acquired some time ago by the Commissioners, the English Industrials, Limited, has opened communications with the Urban Council with a view to taking over their powers.

Dundee.—At the last Town Council meeting Councillor Longair submitted a letter from the Caledon Shipbuilding and Engineering Company, Limited, making another offer to supply the dynamos and engines for the Dundee electrical station at a cost of £10,208, exclusive of spare gear, the price of which would be the same as previously quoted by them. In a note the letter pointed out that if they secured the order the engines would be made in Dundee, and the city would receive the benefit of it.—Mr. Longair said he thought that if they allowed one firm to make a second offer, they should, in the future at any rate, give all the others a chance of quoting again.—The Lord Provost said they could scarcely take up the matter at that time, and the meeting then broke up.

Edinburgh.—At last week's Council meeting, on the minutes of April 10th being submitted for approval, Mr. Auldjo Jamieson moved disapproval of the recommendation adopted by the Council during his absence to form a reserve fund for the purpose of renewals in the electric lighting department.—Bailie M'Kenzie, in moving the adoption of the minute, explained the circumstances under which the report was taken up in the Committee in Mr. Jamieson's absence. But he did not see that Mr. Jamieson had anything to complain of, as the motion was practically what the Council had carried about two years ago.—After discussion, Mr. Auldjo Jamieson said that he would not press his motion. The minutes were then approved.

The Electric Lighting Committee has resolved, on a representation by the resident electrical engineer, to recommend the extension of the electric lighting subway from Picardy Place to Little King Street, at a probable cost of £1,500. They also recommended the acceptance of several estimates, among which were one for the supply of "feeders," amounting to over £18,000, and another for work in connection with the erection of water-tanks at Dewar Place station, amounting to over £500.

Messrs. James Waldie & Sons have secured the contract for the supply of fuel to the Corporation Electric Lighting Department for the year to June, 1900. The total amount required is 26,000 tons of coal.

Erith.—The Council has received letters from several parties anxious to supply electricity in the district.

Grantham.—The Board of Guardians have resolved to defer the question of having the workhouse lighted by electricity until the cost of installation, maintenance, &c., be ascertained.

Great Yarmouth.—The borough surveyor reports for the quarter just ended the income from the Corporation's electric lighting undertaking was £1,486 11s. 6d., and the expenditure for production £775 12s. 9d. Taking into account repayment of capital, interest, and sundries, the clear profit was £140 18s. 9d. He advises a further outlay of £27,000 for plant to meet increased demands for extension of the light to the populous suburb of Gorleston, and for supply of electric current to tramways. The Electric Lighting Committee recommend an immediate application to the Local Government Board for sanction to a loan for the amount, but the Town Council, as stated last week, before going so far as this, have requested Mr. Preece, their consulting electrician, to report on the scheme. A special meeting of the Committee is to be held at an early date to consider the expediency of reducing the present charges for current.

Hammersmith.—In a recent report to the Vestry the electrical engineer says that the number of consumers has increased from 132, on March 25th, 1898, taking a supply for 8,098 8 C.P. lamps, to 275 consumers, with 19,390 8-C.P. lamps on the corresponding date this year, and there are still 2,480 8-C.P. lamps nearly ready for connection. During the past year the first extension of generating machinery and mains has been nearly completed. The department has received £1,957 10s. for lighting and maintaining arc lamps in the public streets. This sum represents the supply of 145,438 units of electricity, carbons, cleaning, trimming, and daily attendance on the arc lamps to keep them in working order, and also annual repayment of capital and interest thereon. As this amount works out at the low sum of only 3¼d. per unit, it is clear that profit has not been made by charging an exorbitant sum for public lighting. In fact, it has been done at practically cost price. With regard to the private lighting, the Vestry has sold 372,191 units, producing a revenue of £7,181 9s. 5d., or an average price of 4·6d. per unit. This price is amongst the lowest in the London district. The total cost of supplying is £5,484 (just under 2½d. per unit), or 59·4 per cent. of the revenue, which leaves a gross profit of £3,749 5s. 3d., or 40·6 per cent. towards paying interest and sinking fund charges. Owing to the coal strike, the total extra cost for coal was £303 9s., or an increase of nearly 14 per cent. The gross result of the year's working shows a profit of £3,749 5s. 3d., and after the deduction of interest and repayment of capital, will leave a net profit of £1,420 1s. These are excellent results, considering that the period under review is the first whole year's working. When the important extensions now in hand are completed, and after allowing for an ample reserve, the department will be in a position to supply a maximum of 30,000 lamps alight at one time, or a further number equal to double the present output.

The Vestry will, from June 24th, reduce the price to consumers under Scale A to 6d. per unit for one hour and 3d. per unit afterwards.

Various tenders for buildings for the electricity works extensions have been referred to the Electricity Committee.

Hanley.—An explosion occurred in an electric light main box in Vine Street on the 6th inst. On the same day an accident occurred at the electricity works. The main flue in No. 1 boiler house collapsed, and the draught in that house being destroyed only three boilers (half the number regularly used) were left to do the work. Instead of 120 lbs. of steam per boiler, the pressure did not exceed 70 lbs. Consequently the voltage was reduced from 100 to 70. Some inconvenience was caused in the borough by the lowering of the light, but repairs were made by a quarter to eleven.

Heckmondwike.—A meeting of ratepayers last week approved the Council's electric light scheme.

Hendon.—The District Council has appointed Mr. Robert Hammond to prepare a general report *re* electric lighting.

Ipswich.—Before the annual meeting of the eastern district of the Incorporated Association of Municipal and County Engineers at Ipswich last Friday, Prof. Kennedy gave an address on the proposed electrical works at Ipswich.

Italy.—According to the report for 1898 of the Società Edison di Elettricità of Milan, the company's stations at the commencement of the present year were supplying current to private consumers to 69,555 incandescent lamps and 817 arc lamps, an increase of, respectively, 13,352 and 77 on the year. Electrical energy was also being supplied for power purposes to electromotors, aggregating 2,730 H.P.

A Milan syndicate has secured concessions to utilise the water-power of several streams in the neighbourhood of Lake Como. It is stated that the power available will aggregate 10,000 H.P., and a company is being formed to develop the same.

Killarney.—It is stated that a syndicate intends buying the Muckross estate and working the lakes at a profit. Among other proposals is one to utilise the water-power of Torc Waterfall by converting it by a turbine into electrical energy and conveying the same to Muckross House, which is to be used as a factory for extracting the valuable chemical compound, carbide of calcium, from the limestone with which the estate and the country round abounds. It is believed that further electrical energy can be obtained from the flow of the waters from the Upper Lake. It is also proposed to fit out a small electric tramway to make the round of the Muckross demesne.

Lambeth.—By virtue of the deed of transfer of the Vestry's provisional order, the South London Electric Supply Corporation undertook to lay mains in a number of streets, and deposited £5,000 with the Vestry as a guarantee for the completion of the works, that sum to be forfeited in the event of the obligations in this respect not being fulfilled within three years. The company have now informed the Vestry that, with the exception of short sections of mains in Camberwell New Road, Kennington Road, Harleyford Road, and Kennington Oval, they have completed the laying of the compulsory mains, and now asked to be excused for the present from proceeding with this particular work, on account of the poor prospects of obtaining custom on those four sections. Having considered the question, the Vestry at the last meeting resolved to inform the company that the better course will be for them to carry out the whole of the undertaking, and lay the mains in all the streets specified as compulsory in the deed of transfer.

Leamington.—After sitting in private for some time on Tuesday to consider the special changes which the Board of Trade proposed should be inserted in the provisional order for electric lighting in the borough, the Council resolved to accept the order as amended by the Board of Trade, and that the Electric Light Committee be instructed to forthwith enter into negotiations with the company with a view to acquiring the undertaking.

Limerick.—The committee appointed to consider the proposal of the Dublin District and Provincial Electricity Syndicate for the purchase of the gas works has recommended against the sale. The price offered by the syndicate is £100,000, which represents about 20 years' purchase of the average profit of £5,000. The Corporation committee has also decided not to put in force the provisional order obtained some time ago for electric lighting. It is considered that if a private electric lighting company set up in the city, the competition thus created would be for the city's advantage.

Liverpool.—A memorial received from 160 owners and tenants of property situated in Newsham Park and the vicinity, objecting to the proposed erection of an electric generating station upon land in Lister Drive, Newsham Park, has been allowed by the Council to lie on the table.

Llandudno.—The Electric Light Committee last week elected Mr. T. T. Marks chairman for the coming year. It was stated that when the works were opened on January 5th, there were only 250 lights. By Monday last week that number had increased to 6,000, and the demand was so great that they could hardly cope with the extra wiring, though the machinery was large enough to supply double the current.

London.—At last week's meeting of the Court of Common Council Mr. Algar moved the adoption of a report from the Streets Committee on the subject of the supply of electric current to the City, together with a letter from Sir Courtenay Boyle on the subject. The Committee recommended that the decision arrived at a fortnight ago to the effect that the debate should be adjourned for a month should be rescinded and the debate resumed. Mr. Algar moved that the debate should be taken with closed doors. After a short discussion Mr. Algar withdrew his motion. At the last Court Mr. Algar moved that a letter from the secretary of the City of London Electric Lighting Company suggesting a conference should be referred to the Streets Committee with a view to a meeting. Mr. Algar, in moving the adoption of the report of the Committee, explained that since the last meeting of the Court a letter had been received from Sir Courtenay Boyle. It was evident that the matter could not remain tied up for another fortnight, and if the resolution which was adopted at the last Court was rescinded another fortnight would remain in which the Court could come to some definite decision. He moved, therefore, that the resolution adopted at the last Court should be rescinded. The Court unanimously adopted Mr. Algar's proposition.—Mr. Morton moved an amendment to the effect that the town clerk should be instructed to ask the electric lighting company to submit to the Court in writing any proposition it desired to make.—Mr. Wood seconded the amendment.—Mr. Algar protested against that course being adopted, remarking that it was obvious that it would not save time; on the contrary, much valuable time would be wasted. He asked the Court to make up its mind what policy it intended to pursue. Was the Court going to declare its intention to take advantage of the avoidance of the contracts and to say that it no longer recognised them, or was the Court in a position to say that it would take over the electric lighting and work it? He appealed to the Court to come to some decision, as the position in which the Corporation was at present placed was a serious one.—Mr. Hollington thought that Mr. Morton's amendment was not in the interests of the Corporation, and he advocated the holding of a conference.—Mr. Deputy Johnson said it was all very well for members to talk about the existing contracts being null and void, but the Corporation had accomplished nothing. It had, in fact, only put an end to an obligation. No course for the future had been sketched out. Sir Courtenay Boyle, however, wanted a reply forthwith.—Mr. Millar Wilkinson reminded the Court that only one side had been heard. It was quite possible that the electric lighting company had secured an opinion which was quite opposed to the opinion obtained by the Corporation, as he believed it was a fact that a person could always obtain the opinions he desired.—Mr. Millar Wilkinson said he was referring not to solicitors but to barristers.—Mr. C. T. Harris said it was obvious that the Court could not obtain in a letter alone the information it required.—Mr. Deputy Sayer warned the Court against following Mr. Morton's advice, and being led into another bad bargain.—Mr. Lile said he thought that if the electric lighting company really meant business it would speedily write and say what it was prepared to do in the future.—Mr. Turner asked why the Court did not boldly declare that it considered the existing contracts to be null and void. On a show of hands, Mr. Morton's amendment was negatived.—Mr. Harris then moved that the Streets Committee should be empowered to arrange a conference with the representatives of the electric lighting company, and that the committee should report forthwith to the Court.—Mr. Algar seconded this.—After further discussion, in which Mr. Morton, Mr. Brookman and Mr. Berridge took part, the motion by Mr. Harris was adopted almost unanimously. A conference will, therefore, be arranged, and, as Mr. Algar promised, a report will be presented to the Court at the very earliest opportunity.

The City of London Electric Lighting Company is giving notice in connection with the Southwark electric lighting order, 1891, that it is the intention of the company, after the expiry of one month, to apply to the London County Council, as the local authority, for its approval to alter the standard pressure of the supply to consumers from 100 volts to 200 volts in the company's distributing mains, subject to the variation authorised by such regulations and conditions.

The new extensions erected for the Army and Navy Co-operative Society, Limited, on the site of Hooper's depôt are being wired by Messrs. Laing, Wharton & Down for 90 arc lamps and 470 incandescent lamps. As the society's plant is taxed to the utmost, and there is no available space for extensions, the current will be taken from the Westminster Supply Corporation. The work is being carried out to the specification of Mr. Bernard Drake.

Lynn.—Prof. Robinson, in recent reports to the Electricity Committee as to the progress of the electricity works, said that he thought they would be ready by the end of May. Among the minutes adopted by the Council last week was a proposal to accept the tender of Messrs. Spagnoletti & Crookes for wiring and fitting the theatre with 251 16-C.P. incandescents and a couple of arcs at £308; also an instruction to the engineer to invite tenders for the wiring and fitting of the Technical School, to prepare a schedule of wires, cables, and materials required for the ensuing 12 months, also "to employ fitters as required for wiring and fitting up consumers' premises." Mr. A. Howell, of Dewsbury, has been appointed assistant electrical engineer.

Midgley.—The Sowerby Bridge District Council has written to the Midgley District Council, stating their intention to apply for a provisional order for supplying electricity within the Midgley gas area. Midgley Council, however, propose to apply for a provisional order themselves.

Monmouth.—The Rolls Hall, Lord Llangattock's jubilee gift to the town, has been fitted with 109 16-C.P. and 45 8-C.P. lamps inside, and one 1,500-Brush arc lamp outside. Messrs. Siemens Bros. laid down the plant, and Mr. Waugh carried out the wiring and fitting. The Town Council has resolved to purchase a third turbine engine and dynamo for the electricity works extensions.

Northampton.—Messrs. Lea & Warren have just completed the installation of an electrical plant at the new offices of the *Northampton Mercury*, Parade, Northampton. The rotary printing machines and the linotypes will be worked by electricity, and the electric light is fitted in every portion of the extensive premises. The *Northampton Mercury* will be first printed by electricity in Whitsun week.

Ogmore and Garw.—The Ogmore Valley Electric Light Company has intimated to the District Council that the period of their license is about to expire, and that they intend applying for a new order in July next.

Penzance.—The surveyor's electric lighting and refuse destructor scheme is being printed for the Council to have a full opportunity of considering it.

Perth.—The Electric Lighting Committee discussed the question of sites with Mr. Hawtayne last week. Mr. Hawtayne suggested that a larger plant than that mentioned in his report should be erected, which would cost some £3,000 more. The committee agreed to recommend to the commissioners to adopt a site near the Smallpox Hospital, and Mr. Hawtayne was instructed to prepare plans and specifications for the execution of the necessary works—making provision for the larger plant which he suggested should be erected—for the consideration of the commissioners.

Rhyl.—The District Council has decided to apply for information as to the working of the Horsfall destructor system at Bradford, Leeds, Oldham, &c., and also to communicate with Messrs. Beaman & Deas, whose system has been accepted at Llandudno and other places.

Rochester.—The city surveyor having notified to the Corporation that the Chatham Electric Light Company are in the habit of opening up the roads and pavements for their purposes without proper notice having been given, it was resolved that the town clerk require the company to give three days' notice provided for by the Statute.

Russia.—The plant at the Fontanka central station of the Société d'Eclairage Electrique de Saint Petersbourg now comprises six units of 500 H.P. and a seventh 500-H.P. engine and dynamo is at present in course of erection.

Ryde (I.O.W.).—As soon as the Council has procured its provisional order, a special meeting will be held to discuss what to do with it.

Sheffield.—Mr. Bennett had given notice of a resolution for last week's Council meeting to instruct the Watch Committee to report as soon as possible as to the electric lighting of the main central streets where the tramway posts are already erected or are about to be erected. He withdrew the motion, however, but at the same time expressed the hope that the different committees would see their way to adopt the electric light, and so encourage its use by other people in the town.

The Electric Lighting Committee last week held back their recommendation that a new 1,000-kw. steam alternator be purchased from Messrs. Ferranti, because they wanted an opportunity for further considering the question.

South Shields.—The Town Improvement Committee last week decided to substitute the electric light for gas in Westoe village and about a dozen streets in the borough.

The Guardians have adjourned for a month a proposal to consider a scheme to provide plant to generate its own electric supply for the workhouse.

(*Continued on page* 821.)

THE POTTERIES ELECTRIC TRAMWAYS.

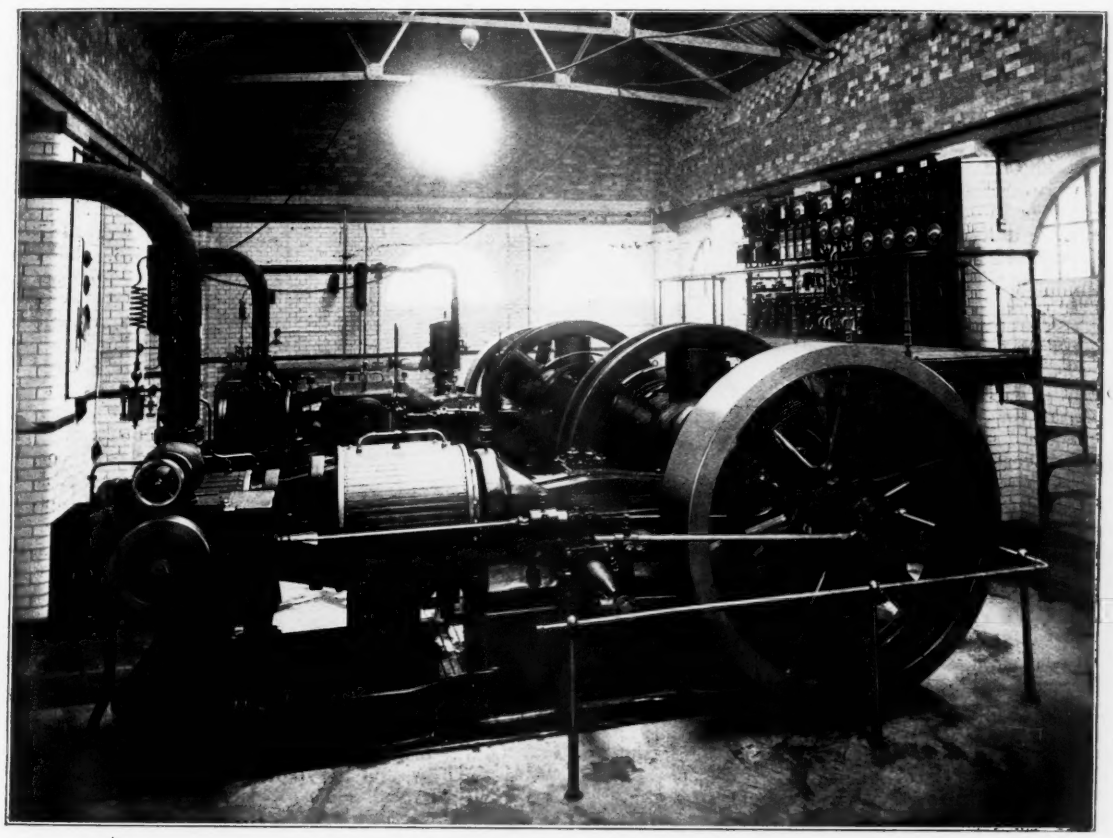
It is doubtless well known to many of our readers that there is in course of construction in the district familiarly known as the Potteries an extensive scheme of tramways and light railways. When completed the system will be 33 miles in length, and will serve the needs of one of the greatest industrial centres of the country, and one which has been hitherto badly catered for in regard to means of transit and communication.

This important development in electric tramway enterprise is being conducted under the ægis of the British Electric Traction Company, and the paramount advantage gained by the work being undertaken by one company is that the system will be continuous and uniform throughout.

The districts through which the lines radiate comprise seven important towns and many intervening villages, and it is clear that the efficiency of a tramway system which connects so many different places, all, doubtless, with conflicting interests, would depend upon the working arrangements being in the hands of one authority.

Not only do we thus obtain a continuity of policy in the administration of the system, but traffic arrangements and conditions of service generally throughout the district are in complete accord; moreover, the economy of working one large system is obviously greater than the average efficiency of a number of small ones. Following the method usually adopted by the British Electric Traction Company in the development of local tramways, a subsidiary company—the Potteries Electric Traction Company, Limited—was formed to work the lines under discussion. It has a capital of £400,000, and the objects of the company were to construct new lines in the Potteries district of South Staffordshire and to acquire the tramways belonging to the North Staffordshire Tramways Company and the tramways in the Borough of Longton, and of working all such tramways and light railways as one undertaking by the overhead system of electric traction.

It will afford some indication of the importance of the district from a tramway point of view when it is mentioned that the population is estimated to be 385,740. That it is thickly clustered is shown by the following table, which gives the number of inhabitants of the towns to be served by the tramways:—



Potteries: General View of Power House.

	Present estimated population.	
Hanley	57,700	
Longton	36,050	
Burslem	34,410	
Stoke-on-Trent	25,240	
Fenton	19,500	385,740
Newcastle-under-Lyme	19,380	
Tunstall	17,969	
Intervening and adjacent areas	175,500	

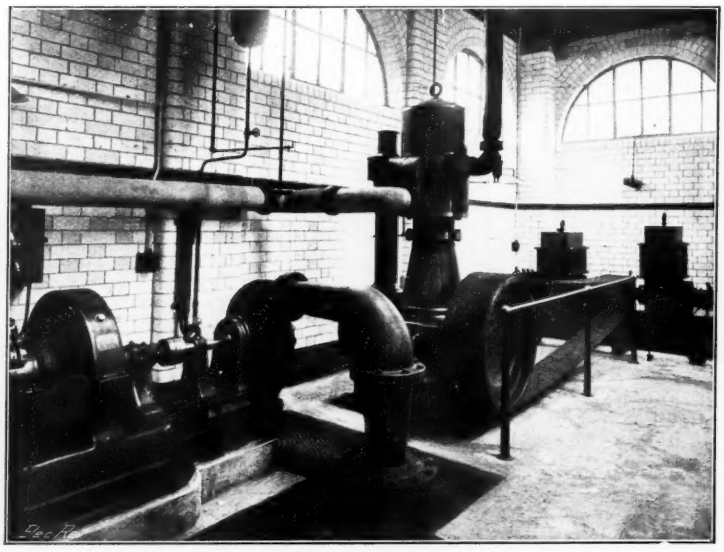
The powers to construct tramways in the various districts of the Potteries were not obtained simultaneously, hence it follows that certain sections will be completed before other portions of the system. The section we are about to describe comprises practically the lines formerly owned by the North Staffordshire Company, which have been now completely equipped for electrical working. The power

hitherto employed on these tramways was steam, the total length of track thus operated being 6½ miles. From the records of 1897 we gather that the number of steam engines then in use was 20, the cars numbering 22. The mileage for the year was 174,916, and the passengers carried numbered 1,989,047. The traffic receipts per mile run stood at 14·75d., and the total expenses per mile run 9·04d. The average dividend paid on the ordinary shares was 3 per cent.

The contract for the electrical equipment was let to the Brush Company for £57,418, but they sublet some portions of the contract as follows:—

Buildings	Mr. Arthur Fawkes, Loughborough.
Overhead equipment and engines.	Messrs. Blackwell & Co.
Generators and motor equipments	British Thomson Company.

It might appear strange that the Kidderminster contract which was given to the Brush Company was entirely equipped with their own plant, and the present one, also given to the Brush Company, is equipped with American plant. The matter is, however, easily explained. The North Staffordshire contract was considerably anterior to the one relating to Kidderminster, and was obtained at the time when the Brush Company were not manufacturing equipments. Although the Kidderminster line has been finished some time, the contracts were given out at a later date than those for North Staffordshire.



Potteries Electric Traction: View of Motor-Driven Pump and Motor Generator.

The power house is situated in Stoke-on-Trent, on the site of the original tramway depôt, the line or section we are describing running in either direction; on one side as far as Longton and on the other side of the generating station as far as Burslem. As we have previously explained, this portion of the system comprises only a small part of the extensive lines the British Electric Traction Company are now engaged on. The plant at the power house, some of which is illustrated in these pages, consists of B.T.H. Co. multipolar machines driven by McIntosh & Seymour engines. There are two dynamos, and they have each a capacity of 100 kw. The engines are horizontal compound condensing. Ledward ejector condensers are used, and are supplied with water by a Gwynne's "Invincible" centrifugal pump which is direct coupled to a motor.

In one corner of the engine room is a 30-kw. generator, which may be driven direct from the bus bars of the line, or alternatively may be driven by an "Universal" engine belted on to a pulley, which forms a coupling between the motor and the generator.

The switchboard is of the usual tramway type; it is divided into panels, on which are placed the necessary instruments.

A distinctly interesting feature of the power house is the negative boosters, of which there are two sets; but further reference will be subsequently made to these. The steam-raising plant consists of two Danks boilers, 30 feet by 7 feet, and having flues 2 feet 9 inches. The coal bunkers are arranged so that coal may be shot into them. A Green's economiser, the scrapers of which are driven by an electric motor, is employed, and for the feed water a Hayward-Tyler three-throw pump steam driven is used, as well as an electrically driven pump with variable speed pulleys. A cast-iron feed water tank, capable of storing 12,000 gallons, is erected contiguous to the boilers, and this is supplied with water from the street mains.

(To be continued.)

OCEANIC RESEARCH AND THE SUBMARINE TELEGRAPH.

Mr. R E. Peake, M Inst C.E, and Sir John Murray, K.C.B., F.R.S., in a communication to the Royal Society of Edinburgh on the survey of the cable route between Bermuda, Turk's Island, and Jamaica, ss. *Britannia*, 1897, have given in a concise and comprehensive form the results of the work.

Before dealing with this paper it may not be inappropriate to make some reference to previous work of a similar nature, so that the reader may better appreciate the situation.

Since the cruise of H.M.S. *Challenger*, 1873 to 1876, the science of oceanography has received valuable contributions from those who have directed their energies to the carrying out of the important enterprises comprised under the head of submarine cables.

Before the advent of the under-sea telegraph the question arose, What's the use of deep sea soundings? and at that time it was as difficult to answer in categorical terms as Franklin's question, What is the use of a new born babe?

In the discovery of the famous submarine telegraph plateau between Cape Race, in Newfoundland, and Cape Clear, in Ireland, a line of soundings some 40 to 50 miles apart, was considered sufficient evidence to justify the laying of a cable across the ocean, and the assumption that the cable of 1858 so soon ceased to pass any current owing to its being constructed on erroneous principles was less than half the truth, for its projectors had not the light that deep sea soundings, as carried out in the present day, casts upon the bed of the ocean.

The excuse for the poverty of the preliminary survey lies in the fact that the methods in vogue for making soundings in those early days were primitive, and the knowledge of the specimens obtained from the bottom was small. The officers of the surveying vessels often judged these to be clay, but examination by eminent microscopists has since proved that they are filled with minute calcareous shells of Foraminifera, and minute siliceous shells of the Diatomacea.

To-day we have improved upon the knowledge given us by early explorers, but experience has had its share in stimulating it. During the laying of the first cable between Lisbon and Madeira in 1874 by the cable ship *Seine*, the preliminary soundings were taken at distances of about 25 miles apart, and showed a tolerably level bottom, with an average depth of rather over 2,000 fathoms. Slight unevenness of the bottom was met with, but no one supposed that this indicated anything that could interfere with the laying of the cable, or its security when laid. During the

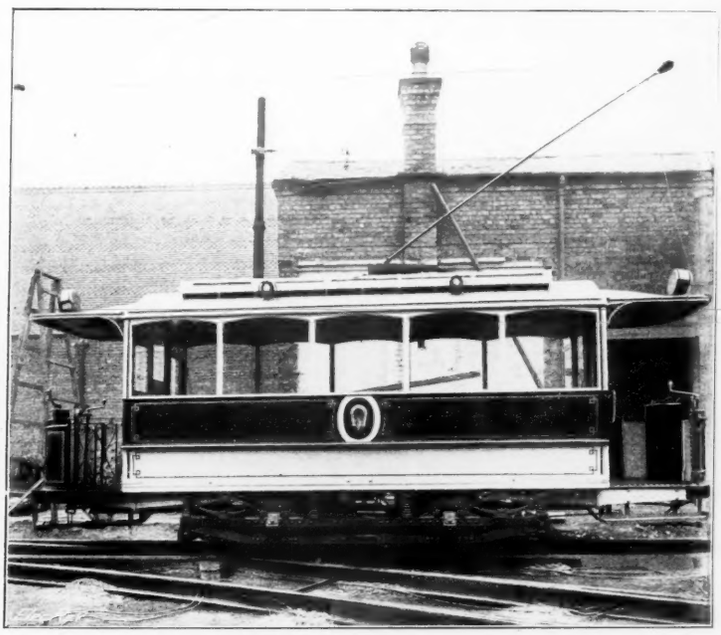
process of laying, however, and when the ship was passing over one of the irregularities indicated, the cable suddenly parted, and on sounding, a depth of *one hundred* fathoms was found in place of the *two thousand* expected. The sudden shoaling of the water had caused the cable to snap. No blame could be attached to those in charge of the work, because the soundings on which they based their calculations were considered, in light of those days, sufficiently close, and were supposed to give a guarantee of suitable bottom.

Subsequently, in 1883, and prior to the laying of the cables between Spain and the Canaries, the ships of the expedition, which was dispatched from London on this work, were fitted out with the most modern appliances, and preparations were made on an extensive scale for a thorough survey of the route. Mr. J. Y. Buchanan, F.R.S., of the scientific staff of H.M.S. *Challenger* volunteered to assist, and his experience and knowledge proved to be of the greatest service.

In a communication to the *Times* of December 7th of that year under the head of "Telegraph Enterprise and Deep Sea Research," Mr. Buchanan remarks that "the sea, from being represented on the chart by a mere blank of white paper, now contains more soundings than any other piece of deep water on the globe."

Over 500 soundings were taken by the two ships of the expedition, and altogether, in the survey of the sea for a cable 700 miles in length, an aggregate of over half a million of fathoms of soundings were made.

Almost on the direct line between Cadiz and Tenerife an extensive bank was found covered by only 50 fathoms of water, and rising with steep sides from the general level of the ocean bed to a height equal to that of the Peak of Teneriffe above the sea surface.



Potteries Electric Traction: View of Car.

A coral patch was discovered with 435 fathoms at its shoalest part extending in east and west direction for 6 miles, and 3½ miles from north to south, with such precipitous sides that in one "cast" on the western ledge the sounding weight after striking bottom in 550 fathoms, tumbled over and continued to sink, struck again in 620 fathoms, again tumbled over, and finally found a resting place in 835 fathoms. The coral from this patch was examined by Prof. Moseley and pronounced to be Lophohelia Prolifera. It was found to be growing luxuriantly, the living stalks being rooted on dead branches of the same species.

Taking the result of the *Britannia's* work in oceanographic surveying, and reviewing the points worthy of notice, it is remarkable that no indication has been found of any upheaval similar to that which has produced the Bermudas group of coral islands, and shoals, crowning as they do, an eminence which rises abruptly out of the deep water of the Atlantic.

The 182 soundings taken by the *Britannia* over the course along which the cable was to be laid, and covering a strip of ground some six miles wide, have demonstrated to the satisfaction of the engineers of the expedition the evenness of the sea bottom in this locality, with its almost uniform depth of over 3,000 fathoms.

The undoubted evidence (adduced by sounding No. 91) of hard bottom, or a hard object, in such a great depth as 2,994 fathoms is of deep interest, and it is a pity that the material brought up, consisting of small granules composed of calcite, should render it scarcely possible, in the opinion of an expert in the British Museum, to determine its source—whether of organic or purely mineral origin.

When experts are reticent as to such a rare find in the very deep water, it is well to refrain from speculation. At the same time, we should feel inclined to view such a spot with suspicion, and to such "a stony couch, bereft of its oozy bed," take care to give as wide a berth as possible in finding a resting place for our cable.

The formation of a coral bank on the western side of Grand Turk Island appears to be an illustration of the "piling of Pelion upon Ossa." The vast area covered by the South of Florida, the Bahamas, and Cuba, is one teeming hive of building polyps that, in a variation of the words of Tennyson, they may be said to "rise on stepping stones of their dead selves to higher regions."

The discovery that the south rocks near Sand Cay in the Turk's Island Passage are half a mile in error on the chart is a useful correction, and serves to show the care taken in carrying out the survey.

The ridge or bank with 200 or 300 fathoms, which was found to join the Turk's Islands to the Caicos, would have been an awkward barrier had the establishment of a cable station on Turk's Island not averted it. It is not stated by Mr. Peake whether the formation of this ridge is coral, but judging from the character of the bottom deposits in the vicinity, viz., Coral Mud and Coral Sand, we assume that it is.

Mr. Peake states that the cable between Bermuda and Grand Turk's Island lies in by far the deepest water of any cable laid up to the present time, not only in the maximum depth attained, but also in the average depth of the whole section. The deepest water obtained on the route of the cable was 3,113 fathoms, and the mean depth from cable house to cable house 2,732 fathoms.

In one continuous run of 24 hours, during which 172 miles of cable were payed out, the average depth was 3,044 fathoms.

The mean depth and mean temperatures along the route followed by the cable between Bermuda and Turk's Island over a distance of 750 miles, were, Mr. Peake states, determined with considerable accuracy. The difference between the observed temperature by thermometer and the calculated temperature from the observed resistance of the laid cable by Matthiessen's coefficient for the resistance of copper at different temperatures amounted to 3·2° F. It appeared at first that this discrepancy was due to an error in thermometer values, but the instruments having been verified at Kew, the supposition was not warranted. This led to a determination of the coefficient by tests carried out on the return of the expedition by Mr. H. A. Taylor, and these tests showed that the temperature coefficient for the class of copper used in the cable was sensibly different from the coefficient obtained formerly by Matthiessen; the alteration, it is said, having certainly only occurred within the last few years, and that this may be probably due to electrical deposition, being now employed in the manufacture of conductivity copper, thus giving increased density, and consequently higher conductivity. The new coefficient applied to the observed resist-

ance of the laid cable gave a mean temperature of 36·26° against 36·57° F. by thermometer.

The notes which Sir John Murray makes on the deposit samples obtained by the ss. *Britannia* are complete in detail. The deposits submitted for examination numbered in all 116, and are from depths varying between 224 and 3,150 fathoms. Arranged in zones of 500 fathoms they appear as follows, viz.:—

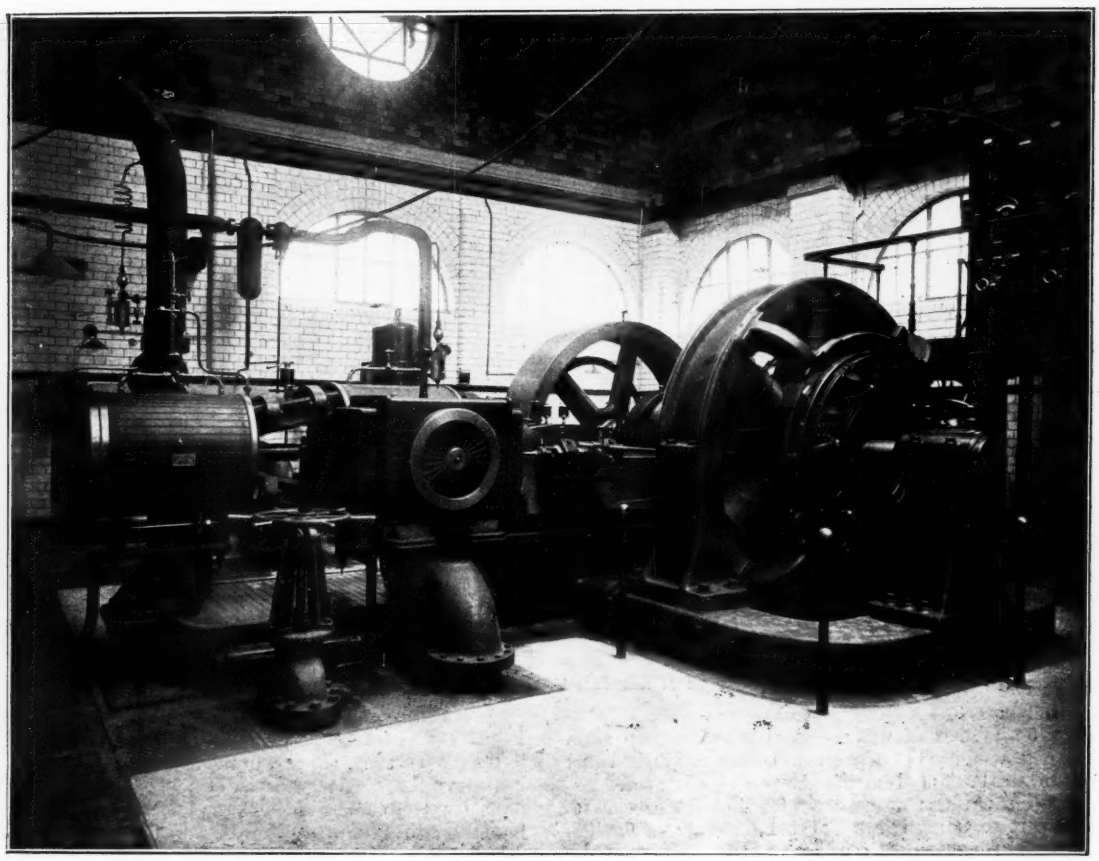
17	samples	come	from	depths	less than	500	fathoms
22	"	"	"	between	500 and 1,000	"	
4	"	"	"	"	1,000 " 1,500	"	
2	"	"	"	"	1,500 " 2,000	"	
7	"	"	"	"	2,000 " 2,500	"	
45	"	"	"	"	2,500 " 3,000	"	
19	"	"	"	greater than		3,000	"

The sea bottom in the very deep water is shown to be covered by Red Clay, extremely uniform in character and in composition.

For 78 soundings, tabulated under the greatest depth as Red Clay, the description as set forth in the summary gives the percentage of Calcium Carbonate, for Red Clay of a brown colour, as 11·5 per cent., with a few pelagic Foraminifera and coccoliths. A residue (88·5 per cent.), minerals (2 per cent.), Siliceous Organisms (1 per cent.) Sponge spicules, Fine Washings 85·5 per cent.

(*To be continued.*)

A Novel Mono-rail System.—A French engineer, M. H. F. Caillet, has brought out an entirely novel mono-rail system. It is unpretentious, and does not aim at high velocities. The invention is simply a single rail laid on the ground or on the usual sleepers, and the vehicles are carried, like bicycles, on two wheels in line, fore and aft. There is no attempt at an exact balance. For a manual truck there is a laterally projecting handle on which a man pushes, and so moves the truck along. The load is adjusted so as to balance as closely as desired, and the man who pushes has no load to carry. In fact, he may arrange so as to require to bear down on the bar. Similarly, for animal traction, the same lateral bar is employed and slung to the saddle, but the bar is usually arranged double, one being attached to each end of the vehicle, and they are connected by a longitudinal bar which is attached to the saddle and collar. The animal bears no unnecessary or undesirable load. Given width sufficient for both truck and animal, and it is easy to see how cheap and convenient may be such a method for constructing pioneer railways. The *Engineering Times*, which illustrates and describes the system, states that at Caborca, in Mexico, a line of 21 miles in length, with rolling stock to carry 100 tons per day over the line, only cost when equipped £240 per mile, and it is certain there must be many hundreds of miles of road in countries like Spain or Venezuela where such railways would effect enormous economies upon the pack mule. A mule, now limited to 300 lbs. of load, would do treble the work on the mono-rail. The difficulty, however, which will be chiefly obstructive is that of breadth. Still, the economy possible would enable an occasional narrow part of road to be blasted out to sufficient width. There are, no doubt, many miles of country roads even in England where such a system would enable greater loads to be carried, owing to the reduction of friction. The mono-rail should be adaptable to electrical work. It might be made so in two ways—either by using a light animal as the balance-pole bearer, and electrical power to do the real traction, or by carrying the balance-pole on an arm with a light wheel on the ordinary road surface, the load being carried on the single rail, which could be most cheaply laid alongside roads not suited to heavier systems. The running friction of the mono-rail is very small, and an illustration is given of a truck of 4 tons capacity drawn by two horses up a grade of 1 in 20. We believe there is a field for this simple railway. A mono-rail system which aims at slow speeds is novel.



Potteries Electric Traction: View of Single Set.

ELECTRIC LIGHTING NOTES.

(*Continued from page* 816.)

Shoreditch.—The Vestry on Tuesday approved the action of the Lighting Committee in instructing Mr. Newton Russell, chief electrical engineer, to obtain estimates for a lathe, a 2-horse-power motor, and one light and one heavy drilling machine for the new workshop. It was decided to authorise the Committee to purchase the plant as recommended by the engineer. The Protector Lamp and Lighting Company, of Eccles, near Manchester, submitted a tender, offering 5s. per lamp per annum for the privilege of advertising on the gas and electric lamps, totalling 1,175, for a period of three years. The offer, which was the only one received in reply to advertisement, was, however, not entertained.

Southampton.—31,739 units were sold during the month of April, being an increase of 14,231, or 81 per cent. over the number sold in April, 1898; the equivalent of 1,238-C.P. lamps were connected in April, bringing the total up to about 20,500. The electrical engineer has reported that a momentary rise of pressure on the positive side of the network occurred on Saturday, April 22nd, at 9.30 a.m., due to the starting resistance of the negative balancer being short circuited. The result was to break several lamps on consumers' premises and to blow fuses. The broken lamps were being replaced on application at the works. The starting of the balancer had since been effected by a different method, which prevented the possibility of the short circuit occurring again. The contract for the extension of the station for the battery house has been placed with Messrs. Playfair & Toole.

Southport.—The Council has passed the minute of the Electricity, Finance, and Tramways Committees, recommending the borrowing of a sum of £55,000 for electricity purposes.

Stafford.—The Electric Lighting Committee reported to the Council on Tuesday that they had large extensions under consideration. During the past year the undertaking has been fairly successful, the amount of electrical energy generated showing an increase of over 15 per cent. on the previous year, and the number of 8 C.P. lamps or their equivalent connected being 7,346, an increase of 1,146. The department have been able to pay the whole of their working expenses and interest upon borrowed capital, but the payment to sinking fund in reduction of capital will have to be drawn from the balance standing to the credit of the department.

Stirling.—The National Electric Free Wiring Company, Limited, has been bringing a free wiring proposal before the Police Commission Lighting Committee.

The Police Commission last week decided to borrow £25,000 for electric lighting purposes.

Sunderland.—The Lighting Committee has resolved to obtain a spare armature for No. 8 steam dynamo, at an estimated cost of £370; that additional instruments for the switchboard extension be obtained, at an estimated cost of £55; that, owing to the increased demand for lighting at the Workhouse, the estimate for extension of mains thereto be increased from £2,200, already sanctioned by the Council, to £2,350.

Taunton.—The electrical engineer (Mr. E. B. Thornhill) has reported to the Council that the second steam alternator has been erected. During the past quarter the equivalent of 1,420 8-C.P. lamps had been connected with the mains.

Teddington.—As a result of the joint opposition of Twickenham and Teddington, the Board of Trade has notified to the District Council that the provisional order will not be proceeded with.

Tewkesbury.—The District Council proposes to make application for a provisional order.

Wakefield.—The Electric Lighting Committee has decided to raise the salary of Mr. Brydges from £200 to £225, and by annual increments of £25 up to £300.

Windsor.—Preparations were begun here on Monday for the celebration of the Queen's birthday by the erection of a triumphal arch of floral design below Henry VIII.'s Gateway, on the Castle Hill. It is to be illuminated at night by 1,000 electric lights. The Guildhall will also be electrically illuminated.

Wormit.—On 10th inst. an electric light installation was inaugurated, the leading inhabitants taking part in the celebration. The streets are to be lighted by arcs. The public will be charged 6d. per unit. The work was carried out by the British Illuminating Company, Limited, of Edinburgh and Newcastle, under the superintendence of their engineer, Mr. Joseph P. Sleigh. The system is a two-wire direct current at 230 volts. The generating plant comprises a horizontal high speed engine by Mr. R. G. Morton, of Errol Works, Perthshire; a dynamo by Messrs. D. Bruce Peebles & Co., Leith. The capacity of the present plant is 350 lights. When completed the installation will be capable of supplying 600 lights, and will include a 300 ampere-hour battery and two sets of engines and dynamos. The present plant with the aid of the battery will supply about 50 houses.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Birkenhead.—At a special meeting of the Council on Wednesday the full scheme of electric tramways was to be considered. Application is to be made for sanction to borrow £208,678 19s. 10d. for carrying out the scheme.

Bolton-Eccles.—The Worsley District Council is conferring with Farnworth, Kearsley and Little Hulton District Councils *re* the advisability of extending tramways through their townships. It is stated that in connection with the Bolton Corporation scheme, several proposals have been propounded whereby the Bolton trams could be extended beyond Farnworth, where the present line finished right on to Walkden, through Worsley and Winton, and a connection established with the present Manchester tramway system at Eccles. Though in its infancy this scheme is said to be quite possible.

Brighton.—The Bill of the Brighton Marine Palace and Pier Company includes among other things a proposal to make and work an electric tramway on the pier.

Bromsgrove.—The Rural District Council has appointed a Committee to confer with a Committee of the Bromsgrove and North Bromsgrove Councils, if they thought fit, as to the application made to the Light Railway Commissioners for power to construct a light railway from Bromsgrove to the railway station, and from Rock Hill, Bromsgrove, to Lickey End.

Chatham and Gillingham.—Sir Courtenay Boyle held an inquiry on 12th inst. at the Board of Trade, Whitehall, to hear objections to the confirmation of the order authorising the construction of a light railway to be worked by electric traction between Chatham and Gillingham. Messrs. Ashurst, Morris, Crisp & Co. represented the Chatham and District Light Railway Company, the promoters of the scheme. There was no objection to the order, but the representatives of the various authorities sought to insert clauses for the protection of the roads, pipes, and sewers.

Huddersfield.—The Tramways Committee of the Huddersfield Corporation has decided to recommend the Town Council to include in their next Parliamentary Bill an application for powers to extend their tramway system. The proposed extensions would be wholly within the borough boundary. The Lindley section, it is suggested, should be extended to Birchencliffe; the Lockwood section, to the borough boundary at Netherton; the Berry Brow section, to Honley; the Fartown section, to the borough boundary, with a branch off to the Ashbrow Road to Deighton, a circular route from Almondbury to Waterloo by Fenny Lane, and other minor extensions. For several of these extensions Parliamentary powers have already been obtained. The whole of the proposed extensions would measure 11 miles 810 yards. It appears from the statements submitted to the Council that there is a desire on the part of some of the surrounding districts to come to terms with the Corporation in order to have the tramways extended to their respective districts—chiefly Holmfirth, Newmill, Kirkburton, Marsden, and Elland. The total approximate length of tramways necessary to connect these districts is 13 miles, and the estimated cost £130,000. The cost of the extensions referred to within the borough (11½ miles) is estimated at £115,000. The last-named district extensions bring up the total to £245,000. The expenditure is estimated on the cost of electric traction. The Committee recommend that the town clerk be instructed to apply in the next Bill of the Corporation for Parliamentary powers in relation to these proposals. The Tramway Committee will only entertain proposals to extend the tramways undertaking to districts outside the borough on consideration that the local authorities interested co-operate with the Corporation to obtain the Parliamentary powers to construct the tramways suggested.

Leeds.—An effort is being made by the Leeds Tramways Committee to have the equipment for the electrical tramway to Headingley so far advanced by the end of June as to be able, during the three days of the England *v.* Australia cricket match, which commences on the Headingley ground on June 29th, to temporarily run a service of electrical cars between Boar Lane and the Oak. Already the majority of the side brackets are in position, and only the trolley wire remains to be fixed. The new 1,300 horse-power engines will not be ready until some months later, but the *Leeds Mercury* understands that during the three days in question both the present 400-horse engines will be worked. Usually only one of the engines is used, the other being held in reserve in case of any mishap. As the traffic to Headingley during those three days is expected to be exceptionally large, the Committee feel justified in adopting exceptional means for coping with it.

Leeds-Bradford.—The Select Committee of the House of Commons on 11th and 12th insts. resumed the consideration of the competing Bills of the Bradford and Leeds Corporations, which have for their object the extension of the tramway systems of the two towns. The chairman, Mr. Molloy, said that the committee found the preamble of the Bradford Bill proved so far as it relates to that part of the measure which covers the question of tramways, and that the preamble of the Leeds Corporation Bill was not proved so far as the tramway portion was concerned.

Limerick.—The proposed electric tramways gave rise to a short discussion at last week's meeting of the Harbour Board. The secretary read a letter from Mr. F. M. Fitt, solicitor, lodging the particulars, and stating that an application under the Tramways' Act was to be made to the Lord Lieutenant in Council, through the

Limerick Corporation, and as the proposed tramways would affect portion of the Harbour property, the board were asked to state whether they assented to, or dissented from, or were neutral to the proposed scheme. After discussion, the matter was left over until the Corporation has decided upon the matter.

London.—The Board of Trade have recently confirmed the London United Tramways, Limited (Light Railway Extensions), Order authorising the construction of light railways in the County of Middlesex from Uxbridge to Hanwell.

Lowestoft.—The Light Railway Commissioners held an inquiry last Friday into the application of the East Anglian Light Electric Railway Company for powers to run from Southtown to Kessingland, through Lowestoft. Among those present were Mr. J. F. Albright (managing director of the Drake & Gorham Electric Power and Traction Company), Mr. Walter Beer (of Messrs. Seaton and Beer, engineers for the scheme), and Mr. W. C. C. Hawtayne (electrical engineer and joint engineer for the scheme). Mr. Beer, in the course of his evidence, said that the gauge would be 3 feet 6 inches, the overhead wire system being adopted, current being supplied by the Corporations of Yarmouth and Lowestoft. Evidence in opposition was given against the scheme by the Great Eastern Railway. Various other points were raised, and these Lord Jersey intimated would be duly considered.

Newcastle-on-Tyne.—The report, or as it has been called "public manifesto," which was recently prepared by Mr. Laws, the borough engineer, in the course of which he wrote in no unmeasured terms against the adoption of the overhead trolley for Newcastle, has been withdrawn. It was an ably put together report, no doubt, but it was not in accordance with the remit of the Council, and, further, in the words of the chairman of the Tramways Committee, it "cast serious reflections upon the members of the Committee." The Committee had a long debate on the matter last week, after which Mr. Laws said he was astonished to find that his report had caused personal pain to committeemen and councillors, and he expressed his regret and asked to be allowed to unconditionally withdraw the report. This was agreed to, and he will now report as to the Council's simple remit, which was: "As to whether in the streets in the centre of the city some system other than overhead traction is practicable, to be worked in conjunction with the overhead system in other streets."

The New Tramways Committee has resolved that the architect for the power station, car sheds, &c., should be one in business in Newcastle, to work in conjunction with Mr. Hopkinson, electrical engineer. The Purposes Committee was elected to consider and report as to the sections of the new electrical trams. It was the general view that work should be commenced at the very earliest day possible after the passing of the Bill, and that all preparations should be made in the meantime for going on with the work. In a communication from Mr. Hopkinson, it was suggested that the rails should be 108 lbs. instead of 96 lbs., as given in the expert reports, on the ground of greater durability and proportional economy. The committee advised Mr. Laws, borough engineer, to go through to Manchester, where he would see a section of the heavier metal, and be able to talk it over with the electrical engineer.

Plymouth.—No difficulty was experienced by Alderman Bray, the chairman of the Tramways Committee, in persuading the Plymouth Town Council to agree to the extension of electric traction to the Compton section of the undertaking. It was suggested that before the work is actually begun the Corporation should have an opportunity of seeing that electric traction is a success on the Prince Rock route which will shortly be opened. In order to give effect to this it was proposed to strike out of the Committee's recommendation that "upon sanction being received the scheme be proceeded with as quickly as possible" the last four words, but this was only done by the casting vote of the Mayor. In any event, however, electric traction will be in operation on the Prince Rock route long before effect can possibly be given to the proposal to extend the system.

Ringsend.—The bricklayers at work on the erection of the Dublin United Tram Companies have struck work because the engineer complained that they were not working hard enough when on overtime.

Staffordshire.—The Board of Trade and the Rowley Regis District Council having given their sanction to the Electric Traction Company for the construction of tramways in the Bradley Heath and Old Hill districts, Mr. Law, of Kidderminster, has been instructed to immediately proceed with the laying down of the rails between Cradley and Netherton.

Stirling.—The electric tramway scheme of the British Electric Traction Company came formally before the Police Commission on Monday. It was remitted to the Lighting Committee.

Swansea.—At Swansea the work of relaying the tramline is rapidly approaching completion and the erection of the generating station is in hand. It is expected that the line will be worked by electricity by the end of the year.

TELEGRAPH AND TELEPHONE NOTES.

Battersea and Post Office Telegraph Wires.—The Vestry recently granted permission to the Post Office authorities to lay underground pipes from Lavender Hill to the eastern boundary of the parish on condition that the pipes were "used solely for Post Office telegraph wires." The secretary of the General Post Office has declined to accept this condition, stating that it is not for a road authority to inquire for what purpose the Postmaster-General proposes to use any telegraphs, and referring the Vestry to the judgment of the Railway Commissioners in the case of the City of London. The Vestry have, however, decided that the condition is a reasonable one, and to inform the secretary that it cannot be withdrawn.

The Excessive Charge for Telegrams to India.—At the meeting of the members interested in the question of the reduction of cable rates, held in one of the committee rooms of the House of Commons the other day, Sir Edward Sassoon presiding, it was agreed that the joint letter signed by the Telegraph Committee of the House of Commons, and by the leading merchants, bankers, and exporters of China, Singapore, and Australia, asking for a Parliamentary inquiry, should be forwarded to the Chancellor of the Exchequer, Mr. Chamberlain, and Lord George Hamilton. In the course of discussion it was intimated that the Viceroy of India was in sympathy with the object of the meeting; and one of the speakers cited figures which showed that only one telegram out of 110 passing between this country and India, the Far East, and Australia is a message of a social character, the other 109 having relation to purely mercantile matters. The expenditure in this connection by London merchants alone was stated to be more than a million and a quarter a year.

German Telegraphs to the East.—In connection with the tendency lately shown by Germany to establish her influence in Asia Minor, we learn that the German Government is about to send an important expedition to conduct an exploration of Asia Minor, Armenia, and Mesopotamia. Long ago it was suggested by Moltke that Germany should make herself the paramount power in the Euphrates basin. In so doing the present landline to India *viâ* Baghdad and the Persian Gulf would fall under German control, and, doubtless, form a serious competitor to the existing joint-purse lines, which are only able to keep up the present high charges for telegrams to India owing to the present bad organisation on the Turkish line. We learn that the German vessel *Altona* has appeared off Muscat, and will probably visit other ports in the Persian Gulf. The reasons given for this action are that, in view of the great importance which the Persian Gulf must one day assume in the communication of Europe with Eastern Asia, Germany cannot preserve an attitude of indifference. The extension of the railway system of Europe to the shores of the Persian Gulf is only a question of time, and should a German cable be laid to the Far East, the only possible route lies across the Gulf, as Germany would naturally desire to avoid the Suez Canal.

The German Trans-Atlantic Cable.—We understand that the cable steamer *Britannia*, belonging to the Telegraph Construction and Maintenance Company, arrived at the Azores early this week to take soundings for the projected new cable between Germany and the United States. The result of this survey will be awaited with interest, as for several hundred miles along the route a depth exceeding 3,000 fathoms may be expected.

The Proposed Pacific Cable.—In the House of Lords on Monday last, the Earl of Aberdeen asked Her Majesty's Government whether, in view of the importance of an understanding being arrived at between Her Majesty's Government and the Governments of Canada and of the Australian Colonies, with reference to the proposed Pacific cable, Her Majesty's Government would be disposed to reconsider some of the stipulations recently set forth by them in relation to the scheme. The feeling on the part of Canada and of the Australian Colonies, so far as he had been able to ascertain it, was that the conditions on which the Government were prepared to offer, "for a period not exceeding 20 years, an annual subsidy not exceeding a *maximum* limit of £20,000 in any one year," were extremely stringent. He was afraid that an impression might be created that the Government did not regard the project with that confidence which they had hoped for, and that, therefore, it might not be carried out with such facility as was desirable. The principle giving some contribution having been admitted, he could not help thinking that it would have been a perfectly safe and reasonable course for the Government to have gone a little further, not so much as to the amount, but as to the manner in which their aid was offered. The feeling of Canada and of the Australian Colonies towards the mother country was of an excellent character, and it would be a great pity if anything were done to check their confident expectations regarding the readiness of the Government to meet them at least half way, in such an undertaking as this, which was obviously, either directly or indirectly, for the benefit of the Empire at large. The attitude of the Government, as expressed through the Colonial Office, had been eminently one to encourage and foster the desirable state of feeling to which he had referred, and he hoped it might be possible for Her Majesty's Government to still further strengthen the ties between the Colonies and ourselves, and help forward this great scheme by relaxing something of the stringency of the conditions upon which the subsidy was offered.

In reply, the Earl of Selborne assured the noble lord that there was no intention in the letter announcing the Government's decision upon this subject, either of throwing cold water upon a project of such great public interest, or of conveying that decision in a manner which would seem to be ungracious. The matter had been a good deal discussed in the Press, and, somewhat to his surprise, particular stress had been laid on that paragraph of the letter which stated that the construction of this cable was of greater importance to Australia and Canada than to the United Kingdom. Surely the two propositions were not incompatible. It might be perfectly true at one and the same time that a project such as this might be of great general

interest to the Empire, and also that it would have greater importance to specific portion of the Empire. He thought that what was meant to be expressed in the paragraph stated no more than the fact. It was open to anyone who read the letter to form his own opinion as to whether the particular proposal which the Government made was the best or not in the circumstances, but he did not think that anyone who really understood it in its financial aspect would say that it was ungenerous, because it was nothing more nor less than an offer to bear the full share of the annual burden, which had been suggested as appropriate by the Governments of the colonies concerned, and at the same time not to demand any share in any profits that might arise. That might or might not be the best attitude to adopt, but whatever opinion might be formed in that respect he did not think it could be criticised as an ungenerous offer. The maximum of £20,000 seemed, according to the evidence adduced before the Committee, to be the largest possible sum on the proportion of five-eighteenths that could ever fall upon the Government of this country to bear. The noble earl had commented on what he had described as the stringency and severity of the conditions. Those conditions, however, were only of the kind which the Treasury made it a rule to impose whenever this country bore a share in any project such as this one of the Pacific cable. There was no ulterior motive lurking underneath them. They were merely those which the experience of the Post Office and the Treasury had shown them it was prudent to insist upon as the most likely to conduce to the efficiency of the work and the satisfactory maintenance of the service. But if, as would appear, the Australasian and Canadian Governments had any objections to urge on any ground to the exact form in which this proposal had been made, Her Majesty's Government were perfectly prepared to review the whole matter in the light of those representations, with a sincere desire, if possible, to arrive at a decision which would be mutually satisfactory to all the Governments concerned.

Lord Tweedmouth said he was glad to hear the assurance that this arrangement was open to revision, and that the door was not finally closed. He thought the conditions were extremely stringent and not fair, if all this country was to do was to provide, in the event of a certain deficit, a proportion of it year by year up to the sum of £20,000. He did not look upon the offer made by Government to the Colonies as in any sense a liberal one.

A rumour prevails that a certain cleavage of opinion has taken place within the Government as to the assistance which ought to be given to the carrying out of the cable scheme. At all events, it is asserted that Mr. Chamberlain would gladly see the utmost practical support given to the undertaking.

General approval was expressed at the announcement made by Lord Selborne in the House of Lords that, in view of the dissatisfaction signified by the Australasian and Canadian Governments, Her Majesty's Government are prepared to reconsider their attitude towards the all-British cable scheme. It is understood that Mr. Chamberlain was much impressed by the opinions placed before him earlier in the day by the Agents-General for the self-governing Colonies, and that Lord Selborne's statement, which expressed the sincere desire of Ministers to arrive at a decision which would be satisfactory to all the Governments concerned, was the official intimation of the outcome of the conference.

The Central News is informed that Lord Strathcona and Mount Royal, as High Commissioner for the Dominion of Canada, accompanied by the Agents-General of some of the self-governing Colonies of the Empire, had a conference with Mr. Chamberlain at the Colonial Office on Monday on the subject of the new Pacific cable. The proceedings were private, but the Central News learns that certain modifications of the original scheme were talked over in a friendly way, and that Mr. Chamberlain promised, on behalf of the Imperial Government, that the suggestions made by the Agents-General should have careful consideration. The project has been by no means abandoned, and in official quarters there is very good hope that an all-British cable scheme will before long be an accomplished fact.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Amazon Company's cable—		
Cable beyond Gurupa ...	June 11th, 1898 ...	...
Eastern Telegraph Co.'s cable—		
Ilo Ilo-Bacolod	May 5th, 1899 ...	...
Para-Maranham	April 10th, 1899 ...	...
Landlines.		
Communication between Mossamedes and all Inland Offices.	March 16th, 1899 ...	...
Communication between Salonique and Monastir.	March 23rd, 1899 ...	...
Line between Antofagasta and Cochabambu (Bolivia)	May 9th, 1899 ...	...

The Telephone Question.—It is stated that the directors of the National Telephone Company have made an important modification respecting the rates for exchange telephone service within the County of London. Hitherto the company's ordinary tariff rates have applied only in case where the subscriber's premises are situate within 1½ miles of the company's nearest exchange, and if the premises have been situate at a greater distance an extra charge has been imposed for each additional half mile or part thereof. The directors have now decided that the ordinary tariff rates are to apply generally throughout the County of London without regard to distance, so that any person whose residence is situate within the county will be enabled to obtain the telephone service throughout for £10 per annum.

It is also stated that the National Telephone Company has notified Norwich that it will accept a £5 rental per annum for calls within a radius of one mile from the central exchange. The present rate is £8 for a distance of half a mile. But the company also propose to limit the number of calls under the reduced rate to 800 per annum, while any calls after the first 800 must be paid for at 1d. each, or 6s. per 100 if paid in advance.

The Telephone System.—In the House of Commons on Monday Mr. Rickett asked the Secretary to the Treasury whether the Government could make the provisions of the Telegraphs (Telephonic Communication, &c.) Bill applicable to non-county boroughs as well as to county boroughs; failing this, whether the Government would give special consideration to the cases of those non-county boroughs whose rateable value exceeded that of some of the county boroughs. The hon. member also asked whether it was the intention of the Government to proceed with the Telegraphs (Telephonic Communication, &c.) Bill this Session; if so, whether he could state when the second reading of the Bill would be taken. Mr. Hanbury said, in reply, I am sorry if the Telegraphs Bill has been delayed owing to my absence; but I hope that the second reading will be taken soon after Whitsuntide. It is intended to make the provisions of the Bill extend to urban sanitary districts, subject, of course, to the discretion of the Postmaster-General in individual cases. That, of course, will include places like Scarborough.

Wireless Telegraphy.—It is stated that Brigadier-General A. W. Greely, chief officer of the Army Signal Corps, has issued his report on the recent experiments with wireless telegraphy apparatus. It states that the great delicacy of the system, and constant necessity for the adjustment of the receiver, made the transmission of messages uncertain and unreliable. General Greely doubts whether it can possibly supplant the wire system for ordinary telegraphic purposes, though its value when installed on ships, lighthouses, and lightships should be great. While secrecy of transmission is found to be among the probabilities up to the present stage of the wireless experiments, the report does not warrant a positive prediction that this will be secured in the new system.

With reference to Mr. Preece's lecture on "Ætheric Telegraphy" at the Society of Arts, Mr. H. W. Allen, secretary to the Wireless Telegraphy and Signal Company, Limited, writes to the *Times* as follows:—"I am requested by my directors to state: That the Wireless Telegraph Company are ready at any moment to instal the apparatus for effecting telegraphic communication between Guernsey and Sark and between South Sand Head Lightship and Dover, by Mr. Marconi's system. Considerable correspondence on the subject of the connection between Sark and Guernsey has taken place between the authorities of the Post Office and this company, but up to the present moment that Department has not made an acceptance of the terms which have been laid before them by my directors for carrying out the above work. As an impression may be conveyed by Mr. Preece's remarks that some objection exists on the part of my directors to undertake this work, I am directed to inform you that these installations can be completed within a brief period of the receipt of an order from the Post Office to undertake them. In view of the perfectly successful demonstrations which have been made of the working of Mr. Marconi's system between Dover and Boulogne, a distance of 30 miles, it must be obvious that working between Sark and Guernsey, a distance of six miles, or between the South Sand Head Lightship and Dover, a distance of three miles, would not present the slightest difficulty. It is only owing to the weight and authority of Mr. Preece's name that we feel called upon to ask you to be good enough to insert this letter, as otherwise perhaps Mr. Preece's remarks would lead the public to believe that my company could not or would not carry out the work suggested by the Post Office authorities and Trinity House."

A New York telegram to the daily press says that "Mr. Marconi has been allowed a second patent, covering the inclusion of his sensitive tube in a box, closed except for a small opening, and with a transmitter exterior to it for the purpose of protecting the Hertzian waves from interference except as intended by the operator. Prof. Lodge took out a patent for wireless telegraphy on August 16th last, making a total of three American patents. Prof. Lodge uses an induction coil to increase and intensify the vibrations, and metallic cones to collect them. He claims to be able so to tune and synchronise his instruments as to ensure secrecy in ætheric telegraphy."

On Saturday last the South Foreland lighthouse was visited by a commission from the Dutch Government for the purpose of inspecting Marconi's system.

The Netherlands Government propose to adopt the system on their coast line for defensive purposes, and as a means of communication between lightships and the shore.

CONTRACTS OPEN AND CLOSED.

OPEN.

Barton-upon-Irwell.—June 6th. The Guardians want tenders for the wiring and fitting of their new infirmary buildings, Green Lane, Patricroft. Specifications, &c, from Mr. G. R. Peers, consulting engineer, 96, Deansgate, Manchester.

Battersea.—June 7th. The Vestry wants tenders for the supply of mains, water tube boilers, steam dynamos and engines. See "Official Notices" April 14th.

Bexley (Kent).—May 31st. The L.C.C. Asylums Committee is wanting tenders for the installation of telephones, fire alarms, tell-tale clocks, and call bells at the Heath Asylum, Bexley, Kent. Instructions, &c., can be obtained from Mr. R. W. Partridge, clerk of the Asylum Committee, 6, Waterloo Place, S.W.

Birkenhead.— May 26th. The Corporation wants tenders for the supply and delivery of 100 electric meters. See "Official Notices" May 5th.

Birkenhead.—June 9th. The Corporation wants tenders for one 225-kw. direct current high speed steam dynamo. See "Official Notices" this week.

Blackpool.—May 20th. The Tramways Committee wants tenders for ten bogie tramcars. See "Official Notices" May 5th.

Brighton.—May 29th. The Council wants tenders for the supply of auxiliary switchboards and switchboard gallery at the electricity works. See "Official Notices" May 12th.

Christiania.—May 24th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul-General at Christiania stating that tenders are invited by the Christiania Electric Works until May 24th, 1899, for the supply of electric cables. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m.

Crewe.—June 1st. The Corporation wants tenders for boilers and economisers, engines and dynamos, centrifugal pump and motor, mains, battery, switchboard, and travelling crane. See "Official Notices" May 5th.

Dudley.—June 17th. The Electric Lighting Committee wants tenders for water-tube boilers, economiser, steam dynamos, balancers, switchboard, cables and street work, arc lamps, and travelling crane. See "Official Notices" this week.

Edinburgh.—May 22nd. The Council wants tenders for two steam driven fans for induced draught. See "Official Notices" May 5th.

Enniskillen.—May 22nd. The Urban District Council invites tenders for supplying and fitting up gas engine, dynamo, and complete electric light installation for lighting New Town Hall, Enniskillen, according to plans and specifications prepared by Messrs. Anthony Scott, M.S.A., and Wm. A. Scott, A.R.I.B.A., architects, and which can be seen at their office, 16, William Street, Drogheda, or at the Town Clerk's office, Enniskillen.

France.—May 25th. The French Post and Telegraph Authorities in Paris are inviting tenders until the 25th inst. for the supply of 240,000 porcelain insulators. Particulars may be obtained from, and tenders are to be sent to, Le Sous Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

Hackney.—June 13th. The Vestry invites tenders for trenching, troughing, cables, joint boxes, jointing and house services. See "Official Notices" May 5th.

Halifax.—May 26th. The Corporation wants tenders for 100 tons of 2-inch and 2½-inch cast-iron pipe. See "Official Notices" May 12th.

Islington.—June 1st. The Guardians of the Poor of St. Mary, Islington, invite tenders from persons prepared to carry out the necessary works for the installation of the electric light at the New Infirmary for the Parish at Highgate Hill. Further information, copies of plans, &c., from Mr. W. Smith, architect, 65, Chancery Lane, W.C.

Kertch.—The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul at Taganrog, stating that tenders are invited by the municipality of Kertch for the supply of materials for the construction of electric lighting plant and tramways in that town.

St. Pancras.—May 23rd. The Vestry wants tenders for about 22 miles of lead-covered armoured cables. See "Official Notices" May 12th.

Sheffield.—June 5th. The Health Committee is inviting tenders for engines, electric lighting plant, pumps, shaftings, pulleys, and other engineering work required at the destructor. Particulars and specifications from the City Surveyor (Mr. Wikes), Town Hall, on payment of one guinea, returnable as usual.

Spain.—June 2nd. Tenders are being invited until June 2nd by the municipal authorities of Medina-Sidonia (Cadiz), for the concession for the electric lighting of the town during a period of 20 years. Particulars may be obtained from, and tenders are to be sent to, El Secretario del Ayuntamiento de Medina-Sidonia (Cadiz).

Southampton.—June 5th. The Corporation wants tenders for motor cars and equipment, and the electrical equipment of lines. See "Official Notices" May 12th.

Teneriffe.—June 14th. Tenders are being invited until June 14th by the Spanish Ministry of Public Works in Madrid for the concession for the construction and working of an electric tramway between Santa Cruz de Teneriffe and San Cristobal de la Laguna, Teneriffe. Tenders to be sent to La Direccion General de Obras Publicas (Ministerio de Fomento), Madrid, whence particulars may also be obtained.

West Africa.—July 10th. The Compagnie de Mozambique, of 45, Rue do Alecrim, Lisbon, is inviting tenders until July 10th for the concession for the establishment and working of a central electric power station at Beira for lighting and power purposes during a period of 25 years. Particulars from, and tenders to, above.

CLOSED.

Belfast.—The Electric Committee has accepted the tender of Messrs. J. & W. Stewart for foundations for engines and boilers at the electricity works.

Burton-on-Trent.—The Town Council has accepted the tender of Messrs. J. Fowler & Co., Limited, for the alterations and additions required for the switchboard to accommodate the new machinery (£163 exclusive of fixing); also that of Messrs. Green for economisers at £224 including fixing. The mains are to be extended along a number of thoroughfares and the Manchester Steam Users' Association have been instructed to examine and test the new boilers.

Derby.—The London Crane Works have secured the Council's contract for an overhead hand crane for the electricity works at £195.

Newington.—At the last meeting of Newington Vestry the tender of Messrs. Peto & Radford for wiring the municipal buildings in the parish was accepted in the sum of £630. This was the lowest of seven tenders submitted by the Electric Lighting Committee, the highest being that of Mr. V. G. Middleton in the sum of £1,092 18s. The amounts of the other tenders were as follows:—

	Vestry Hall.	Library.	Lavatories.	Depôt.	Totals.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Free Wiring Company	253 0 0	119 0 0	77 0 0	268 0 0	717 0 0
Brush Company ..	235 16 0	112 17 2	88 5 11	221 11 8	658 11 0
Sharp & Piper	319 0 0	195 0 0	99 0 0	445 0 0	1,058 0 0
Russell & Russell ..	239 0 0	119 0 0	99 0 0	278 0 0	735 0 0
Roger Dawson	282 12 4	148 5 5	84 6 0	474 4 4	989 8 1
Middleton	480 13 0	165 13 0	91 2 0	355 10 0	1,092 18 0
Peto & Radford ..	216 0 0	98 0 0	66 0 0	250 0 0	630 0 0

At the same meeting the tender of the British Thomson-Houston Company, Limited, for the supply of electricity meters, demand indicators, and main fuses, was accepted.

Poplar.—The District Board has accepted the following tenders on the recommendation of the Electric Lighting Committee: Section A.—Engine and pump room equipment (including delivery, fixing and running for one month). Messrs. Crompton & Co., Limited, £15,950 (including £110 for slotted armatures). Section B.—Boiler house equipment (including Babcock & Wilcox boilers). Messrs. Crompton & Co., Limited, £5,940. Section C.—Battery and battery maintenance. Hart Accumulator Company, Limited, £1,255 14s. and £62 10s. per annum for 10 years, for maintenance. Section E.—Public street lighting. Combined arc and incandescent lamp pillars. British Insulated Wire Company; design 6035a, with Holophane globes, at £28 17s. 6d., £29 2s. 6d., and £29 16s. 6d. per post.

Southampton.—The Corporation proposes to accept the tender of Mr. F. Shalders for electric wiring and fitting the municipal lodging house, at £286.

West Ham.—As stated in another part of this issue the Town Council has placed the extensions contract for steam alternators with Messrs. Ferranti, the offensive labour clauses being cut out.

FORTHCOMING EVENTS.

Thursday, May 25th.—At 12 noon. Institution of Mining Engineers, at the rooms of the Geological Society, Burlington House, London. Presidential address by Mr. J. A. Longden; papers by Mr. S. F. Walker on "Alternating Currents and their Possible Applications to Mining" (Part I.); Mr. J. E. Dowson on "Metric Weights and Measures;" and other papers.

At 8 p.m.—The Institution of Electrical Engineers. Annual General Meeting.

Friday, May 26th.—At 10.30 a.m. Institution of Mining Engineers. (Second Day.) Among other papers will be one on "A New Process of Seasoning and Preserving Timber and other Fibrous Substances by means of Electricity," by Mr. H. Baillie-Weaver. Among those open for discussion is one on "Experiments on the Ignition of Fire-damp and Coal-dust by Means of Electricity," by Messrs. Heise and Thiem.

At 5 p.m.—Physical Society, at the rooms of the Chemical Society, Burlington House. Agenda:—(1) "On the Thermal Properties of Normal Pentane."—Part II., by Prof. S. Young and Mr. Rose-Innes; (2) "On the Distribution of Magnetic Induction in a Long Iron Bar," by Mr. C. G. Lamb.

Wednesday, June 7th (also 8th and 9th).—Institution of Civil Engineers. Engineering Conference at Great George Street, S.W.

NOTES.

The Electro-Chemical Company's Works, St. Helens.—The operation at this works, at which alkali and bleach are made by the Richardson & Holland electrolytic process, has been suspended during the past week; and there have been rumours that the stoppage is permanent, and is due to the failure of the electrolytic process. We have made direct inquiry as to the truth of this report, and have been informed by the secretary that the plant has been shut down "for the purpose of carrying out some alterations, but the stoppage is only temporary, and is not owing to the failure of the electrolytic process." It is somewhat unfortunate that the cessation of operations at this works should come at a time when, owing to the disastrous explosion at one of the United Alkali Company's works in the same town, employment for chemical workers will be scarce. As a result of the suspension of manufacturing operations at these two works, for some time to come there is likely to be considerable industrial distress in the town, which, but a few years ago, was one of the busiest centres of the British chemical industry.

A Rubber Substitute from Corn.—The Chicago *Times* has recently published some notes relative to the utilisation of a waste product of the glucose factories for production of artificial rubber. Rubber enters so largely into the composition of many insulating materials, that the following details, taken from the issue of *Electricity*, New York, for March 8th, 1899, may interest our readers:—

> Corn rubber has almost exactly the appearance of the ordinary reddish brown India-rubber. The process of manufacturing is not perfect enough, however, to make it resist heat as well as India-rubber. This has offered the greatest difficulties to the chemists, who are now working to remedy this defect. The oil of corn, from which principally the rubber is made by some secret process, does not oxidise readily, and those who are working on the corn rubber declare this will be an enormous advantage for the new product. Articles manufactured from it will always remain pliable, and not crack. Contrary to reports, this new product has not yet been put on the market. It is intended to go on with experiments till the success of the new substance is assured, and then to go into its manufacture on an immense scale.
>
> The corn-oil from which the rubber is made comes from the germ of the corn, and not from the hull. The starchy and glutinous portions of the kernel are used in making glucose and starch, while the corn-oil, heretofore, according to the refiners, has been practically useless. The five refineries of the trust have used 21,000,000 bushels of corn in the last 10 months, of which about 5 per cent. was refuse. Though 40 different products are made by the company, still 5 per cent. was practically waste. By utilising this waste material in making the new product, it is calculated that corn rubber can be sold at 6 cents a pound, 2 cents of which will be clear profit. The corn rubber, it is said, will be adapted to nearly all the uses that ordinary rubber is capable of, from bicycle tires to linoleum. The more refined uses to which the rubber is put, however, will still be a closed field, for the composition of corn rubber will prevent its substitution for India-rubber for scientific uses.

The artificial rubber is also said to mix well with the natural product. If the properties and costs of this new substitute for rubber are correctly described in the extract given above, it would appear that a new and useful material will soon be placed on the market.

Electric Lighting in Large Cities.—A Pittsburg paper says that, according to a statement made by the Boston Edison Company, the city of Rochester, N.Y., leads all the cities of the world in the number of lamps per 1,000 of inhabitants from central stations. It has 982. Then come Boston with 836, San Francisco with 598, New York with 489, Cincinnati with 475, and Baltimore with 313. No other American cities reach 300 per 1,000 of inhabitants. Of the foreign cities only two, Brighton and Bremen, reach 300, the former having 353 and the latter 338. Paris has 185, London 184, Berlin 178, St. Petersburg 58, Vienna 246, Hamburg 134, Rome 127, Birmingham 75, Liverpool 106, Manchester 173, Edinburgh 242, and Glasgow 72. Twelve American cities with a total population of 9,569,000 show an average number of 450 lamps per 1,000 inhabitants, while 20 foreign cities with a total population of 18,154,000 show an average of 146. The central station system is employed almost exclusively abroad.

Magnetism and Light.—At the Royal Institution last Friday evening, Prof. Thomas Preston, F.R.S., delivered a discourse on "Magnetic Perturbations of the Spectral Lines." Pointing out that the effect of magnetism on light was no new subject of inquiry, he remarked, says the *Times*, that the scanty records of experiments in this direction were probably due to the negative results obtained by investigators. Faraday was the first to succeed in showing that an effect was produced on a beam of polarised light passing through a piece of heavy glass in a strong magnetic field, but he was unable to detect any change in a source of light exposed to strong magnetic influences. It was not until 1897 that any one was able to prove satisfactorily that the refrangibility of the light was affected in such conditions, but in that year Dr. Zeeman demonstrated that certain spectral lines were thickened in a strong magnetic field. Theory indicated that these thickened lines were really triplets, and such they were shown to be by means of another theoretical indication, viz, that the centre one was polarised in a different direction from the outside ones. Hence, by employing a Nichol's prism the centre line and the outside ones could be alternately cut off. Later, by the use of a stronger magnetic field, the lines were actually seen separated, and a still stronger magnetic field revealed that the spectral lines of cadmium and zinc, on which the experiments were tried, were variously modified, appearing separated into groups of six, eight, and nine, and into other complex combinations. In a brief outline of the theoretical considerations by which these difficult phenomena might be explained, Prof. Preston remarked that the inquiry in some degree gave support to the idea that the various metals were built up in some way of the same ultimate elements, and to the old, fascinating protyle theory, according to which all substances were to be reduced to one kind of matter.

Institution of Civil Engineers' Conference.—The Institution of Civil Engineers is holding a three days' engineering conference the week after next at the Institution Buildings at Great George Street. On Wednesday, 7th inst., at 10.15 a.m., Mr. W. H. Preece, C.B., F.R.S., will deliver a short address to all the sections in the theatre of the Institution. Among the works of interest entered in the programme for visitation are the following:—June 7th, Thames Iron Works Company; June 8th, Westminster Electric Supply Corporation station in Millbank Street; June 9th, Central London Railway works, and Siemens Bros. & Co.'s works at Charlton. The papers down for reading include:—

"The Advantages or Disadvantages of Uniting the Lock and Block Signalling Appliances of Railways," by Mr. A. Ross.

"The Relative Advantages of different kinds of Power for Tramways, Light Railways, and Motor Car Traffic, both Heavy and Light." Introduced by Mr. Thomas Parker.

"Methods of Electrical Transformation." Introduced by Mr. James Swinburne.

"Some Non-Integrating Electric Meters." Introduced by Prof. W. E. Ayrton.

"Comparative Advantages of Electricity, Compressed Air and Steam for Mining and Manufacturing Purposes Generally." Introduced by Mr. J. C. Howell.

"Mechanical Traction by Electricity." Introduced by Mr. G. C. Cuningham.

"Economical Transmission and Distribution of Electricity from a Distance." Introduced by Mr. H. F. Parshall.

"Machine Tools; with special reference to American and German practice as compared with English." Introduced by Mr. Arthur Greenwood.

Personal.—Mr. W. H. Preece, C.B., F.R.S., has accepted the presidency of the eighteenth congress of the Sanitary Institute to be held in Southampton from August 29th to September 2nd.

At a complimentary banquet to Mr. D. F. Sugrue, J.P., at the Royal Hotel, Swansea, when the guest of the evening was presented with his portrait and address, it was stated that the British Electric Traction Company had honoured Mr. Sugrue with a seat on the directorate for taking over the Swansea tramway system. Mr. Sugrue has been general manager of the Swansea Improvement and Tramways Company for many years.

Honours.—The Queen has appointed M. Gregoire Massoni, Directeur des Postes et des Télégraphes, at Nice, to be an honorary member of the Fifth Class of the Royal Victorian Order.

Electric Railway Equipments.—We understand that Mr. Sydney H. Short has taken up residence in this country for the purpose of acting as consulting engineer to a concern which is being started at Preston by Messrs. Dick, Kerr and Co. The new works, which will be situated opposite to the electric car works quite recently opened at Preston, will be equipped for the manufacture of electric railway motors, generators, controllers, &c. The works are to be equipped with electrically driven machinery throughout, but we regret to hear that the order for this has had to be given to a Belgian firm. The reason is that the firm in question undertake to have the machinery working within six months, whereas no English firm would guarantee under 12 months. The capital of the new concern, in which Messrs. Dick, Kerr & Co. are the principal members, is stated to be £200,000, and it will manufacture both for home and foreign trade. It is considered that the motors, &c., as manufactured in America do not in every way conform to the conditions of English traction work, and the new company will overcome this drawback in the apparatus to be turned out at Preston. January, 1900, is given as the date for the works to be in full swing. Some idea of the capacity of the works may be gathered from the fact that machinery will be laid down capable of turning out 1,500 motor equipments and generators of a combined output of 30,000 kw. per annum.

Still Wrong.—We find that although there has been time enough to make some study of the report of the Pacific Cable Committee, our contemporary has not yet corrected its opinion on the amount of slack required in laying such a cable, but repeats the error which we pointed out last week. It has also selected from amongst the evidence such portions as best agree with what appears to be its inclination, and thus makes the total carrying capacity of paying traffic on this cable equal to three words each way. The Committee, however, in their report have given such ideas sufficient contradiction, and it is hardly worth our while to do so again here. As to the statement that, "those who advocate this project do not honestly face the necessity, while they recognise it, of having a duplicate cable laid concurrently with, or immediately after the first," we would ask the writer to honestly recognise the fact that for more than 20 years, until 1891, *all* the traffic to the Far East and Australasia, had to pass over the single cable uniting Madras with Penang, and that the solitary cable from Java to Port Darwin, laid on probably the worst route in the world, was not duplicated for nine years after it was laid in 1871, and then only on the payment of a large annual subsidy by the Australian Colonies to the Cable Company. There are numerous other cases which ought to be within our contemporary's knowledge. The St. Vincent to Brazil cable was not duplicated until 1884, 10 years after the first line was laid. The Aden to Bombay cable was single till 1877, and there are many cases of a similar nature. Apart from the advantage claimed for the duplicated routes, no mention is made of the benefit a single route would derive on a much reduced tariff. There are several other things on which this "weary Titan," staggering 'neath his load of prejudice, might accept correction from us, but our space will not allow us to provide it at present. We have read another criticism on the Pacific cable in a weekly financial review, but when we find that in it reliance is placed on the opinion of the "experts" who recommended a core of 940 lbs. of copper and 940 lbs. of gutta-percha, we do not consider the matter worth further attention, excepting, perhaps, to refer to the slight value which the Committee in their report place on the views of the experts in question, and to point out that on second thoughts these experts had reduced the cost of the core alone on the long section by more than three-quarters of a million sterling.

Electrical Orders for Japan.—It is stated by a weekly contemporary that owing to European delays in executing electrical orders for Japan, preference is now being given to American manufacturers.

Appointment Vacant.—The St. Pancras Vestry wants an inspector of works in connection with the electricity undertaking at £130 per annum. See "Official Notices" this week.

The Electrical Engineers R.E. Volunteers.—The members of this rapidly rising corps have started their cycling club, and had their opening run on Saturday, when they journeyed down the Portsmouth Road as far as Ripley. After tea at the "Anchor," the ride back to town was accomplished in good time. The men looked very smart in their blue Engineer cycling uniforms with the Service cap. The cycling runs are arranged so as not to interfere with the ordinary drills, and signalling practice will be gone through during the cycling club runs. Electrical engineers, electricians, engine drivers, &c., wishing to join the corps, can obtain all information at headquarters, 13, Victoria Street, Westminster, S.W.

Electric Piping.—As we go to press Mr. W. H. Isherwood writes:—"With reference to the queries in Mr. Nixon's letter, my experience is as follows: A twin wire, though convenient in some cases, is not desirable as a rule. Taped vulcanised 3/22, 7/23, 3/20, and 7/22 will be found more convenient. The Simplex Company's boxes referred to can be fitted with porcelain interiors by which to attach flexible cord, these being listed in catalogue. I have been unable to get a special ceiling rose, which should have a star-shaped porcelain fence dividing it into three parts, each part having a contact plate and a hole for leading in the wires. I have always used Ediswan, Dorman & Smith, or Veritys ordinary pattern ceiling rose, but taking out the fuse, thus leaving a spare contact."

Municipal Electrical Association.—The secretary sends us an advance proof of the programme for the Bristol Convention of this Association. We understand that there has been considerable delay in issuing this, owing to the very great difficulty in getting a sufficient number of papers. The meeting will be held at Bristol from June 14th to 17th, under the presidency of Mr. Faraday Proctor. There are seven papers down for reading, and various trips have been arranged. Visitors are cordially invited, and tickets for the various entertainments and visits may be obtained on application either to the president, Mr. H. Faraday Proctor, Bristol, or to Mr. Ruthven Murray, secretary, at 21, Acton Lane, Harlesden, N.W.

Institution of Electrical Engineers.—The Council nominees for 1899-1900, as mentioned in our issue of May 5th, p. 736, have been duly elected to their respective offices.

NEW COMPANIES REGISTERED.

Buenos Ayres Electric Tramways Company, Limited (61,893).—This company was registered on May 3rd, with a capital of £350,000 in £5 shares (35,000 6 per cent. cumulative preference), to enter into an agreement with Charles Bright, to construct, project, hire, purchase, take on lease or otherwise acquire in the Argentine Republic or elsewhere in South America, tramways, light railways, cars, omnibuses, engines, rolling stock, electrical and other plant and machinery, &c., and to carry on the business of carriers of passengers and goods, van, omnibus, tramway and light railway proprietors, suppliers of electricity, electricians, electrical and mechanical engineers, &c. The first subscribers (each with one share) are:—C. H. Bennett, 68, Coleman Street, E.C., solicitor; H. Slack, 11, Ellerdale Street, Lewisham, S.E., secretary; Norrie Sellar, 7, Mandeville Place, merchant; R. G. Fudge, 38, Beecroft Road, Brockley, secretary; James Oliver, 13, Canfield Gardens, N.W., gentleman; T. Godwin Chance, 7, Pathfield Road, Streatham, gentleman; John J. Scott, 14, Percy Circus, King's Cross Road, W.C., writer. The number of directors is not be less than four nor more than seven. The subscribers are to appoint the first; qualification, £200; remuneration, £1,000 per annum, divided between them.

Entwistle & Stephens, Limited (61,934).—This company was registered on May 4th, with a capital of £25,000 in £1 shares, to acquire the business carried on by "Entwistle & Stephens," at Baldwin's Gardens, Gray's Inn Road, W.C., and at 12, Farringdon Avenue, E.C., to enter into an agreement with Albert H. Entwistle and Henry J. Stephens, and to manufacture and deal in shades for gas and electric light, lamps, gas fittings, electric light fittings, &c. The first subscribers (each with one share) are:—A. H. Entwistle, Baldwin's Gardens, Gray's Inn Road, shade manufacturer; Henry J. Stephens, Baldwin's Gardens, Gray's Inn Road, W.C., manufacturer; George Wingfield, 15a, Paternoster Row, E.C., chartered accountant; Frank R. Marten, 118, Devonshire Road, Forest Hill, S.E., solicitor; John R. Edwards, 26, Pennard Road, Shepherd's Bush, W., chartered

accountant; Arthur Canter, 37, Arlingford Road, Brixton, S.W., clerk; and John H. Galloway, 15, Gray's Inn Square, W.C., clerk. The number of directors is not to be less than three nor more than five; the first are A. H. Entwistle, H. J. Stephens, and Walter W. Hare; qualification, £500; remuneration, £50 per annum, divided between them.

Marine Propulsion and Electrical Generation Syndicate, Limited (61,952).—This company was registered on May 5th, with a capital of £50,000 in £1 shares, to adopt an agreement with Wm. T. Carter, John A. Dawson, and Thomas Gray, and to acquire, develop, and turn to account certain undescribed patents, rights, concessions, inventions, &c. The first subscribers (each with one share) are:—Wm. T. Carter, Norfolk Road, Maidenhead, engineer; Henry Woodhouse, Thames Hotel, Maidenhead, launch owner; Frederick Francis, Highlands, Maidenhead, insurance broker; Donald Macbeth, Waterloo Place, Hammersmith, engraver; F. A. Dawson, 6, Great Ormond Street, W.C., electrical engineer; Hector A. Convelas, 49, Huskisson Street, Liverpool, commission agent; E. Clive Fowler, Gordon House, Ham Common, Surrey, gentleman. Table "A" mainly applies. Registered office, 6, Dowgate Hill, Cannon Street, E.C.

Maxim Electrical and Engineering Export Company, Limited (61,969).—This company was registered on May 6th, with a capital of £100,000 in £1 shares, to act as agents for the sale in Australia, Asia, Africa, or elsewhere of all goods manufactured by the Hiram S. Maxim Electrical Corporation, Limited, or by J. F. Pease & Co., Limited, and to carry on the business of electricians, mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers. The first subscribers (each with one share) are:—Jules de Meray, 1, Rutland Gate, Hyde Park, gentleman; M. Devenish, 7, Cavendish Place, W., gentleman; Arthur H. English, 61, Wimpole Street, W., gentleman; Hiram S. Maxim, 18, Queen's Gate Place, S.W., gentleman; Maurice Lachmann, 4, Bickenhall Mansions, W.C., engineer; Reginald Peace, Manor House, Hurworth-on-Tees, gentleman; George Terrell, 38, Albion Street, Hyde Park, solicitor. The first directors (to number not less than two nor more than seven) are to be nominated by the subscribers; qualification, £500; remuneration, 10 per cent. of the net profits divided between them.

Edison-Bell Automatic Phonograph (North-Western District) Company, Limited (61,980).—This company was registered on May 8th, with a capital of £25,000 in £1 shares, to acquire from the Edison-Bell Consolidated Phonograph Company, Limited, a license to use and exhibit automatic phonographs, and to carry on the business of phonograph manufacturers, exhibitors and dealers, telephonic, telegraphic, electrical, mechanical and general engineers, electricians, metal workers, &c. The first subscriber (each with one share) are:—James F. Arnold, 55, Victoria Buildings, Manchester, insurance manager; Arthur W. Cross, Gorsefield, Pendleton, Manchester, spinner; J. F. Fielding, Upper Downing, Holywell, land agent; John M. Frost, Dee Mills, Chester, miller; John S. McCulloch, 9, Tithebarn Street, Liverpool, gentleman; David Taylor, 24, Great Cheetham Street, West Broughton, manager; George W. Hinde, 34, Delamere Road, Flixton, cashier. The number of directors is not to less than two nor more than five; the first are the first five subscribers; qualification, £100; remuneration, £500 per annum, divisible.

Imatra Water-Power Company, Limited (61,987).—This company was registered on May 8th, with a capital of £100,000 in £1 shares, to acquire any land and water rights in Finland, Russia, or elsewhere, to establish and carry on works for the utilisation of water-power, and the transmission of force, and to carry on the business of electricians, electrical and hydraulic engineers and manufacturers, suppliers of electrical energy, shipowners, lightermen, carriers, &c. The first subscribers (each with one share) are:—Frederick Lane, 26, Great St. Helen's, E.C., merchant; Leonard Holliday, 52, Rectory Grove, Clapham, S.W., secretary; Wm. Macandrew, 26, Great St. Helen's, E.C., merchant; Julien Dulait, Charleroi, Belgium, engineer; C. S. Gulbenkiou, 120, Bishopsgate Street Within, E.C., merchant; Wilhelm Ofenheim, 1, Schwarzenbergplatz, Vienna, merchant; Firmin Lambeau, Brussels, Belgium, banker. The first directors (to number not less than three nor more than eight) are to be nominated by the subscribers; qualification, £1,000; remuneration, £100 each per annum, and £150 for the chairman. Registered office, 26, Great St. Helen's, E.C.

Buller's Telegraph Construction Company, Limited (62,020).—This company was registered on May 10th, with a capital of £400,000 in £10 shares, to carry on the business of telegraphic, electrical, mechanical, manufacturing and general engineers and contractors, suppliers of electricity, and manufacturers of and dealers in iron, steel, brass, copper, china, earthenware, glass, wooden, rubber and other goods. The first subscribers (each with one share) are:—Howard C. Jobson, Summer Hill, Kidderminster, engineer; Edward J. Chambers, Foxhill, Wombourne, Wolverhampton, engineer; Joseph H. Rice, Clifton Road, Sutton Coldfield, cashier; and R. A. Pinsent, Hume C. Pinsent, A. W. Freeman, and Frank E. Smith, all solicitors, of 6, Bennett's Hill, Birmingham. Registered without articles of association.

Horsfall Destructor Company, Limited (62,042).—This company was registered on May 11th, with a capital of £100,000 in £1 shares, to acquire the business of the Horsfall Furnace Syndicate, Limited, to erect and maintain furnaces, machinery and apparatus, for the destruction of town and other refuse, and the generation of electricity, and to carry on the business of mechanical and electrical engineers, machine makers, boiler makers, iron and brass founders, &c. The first subscribers (each with one share) are:—Arthur Greenwood, M.I.C.E., 16, Great George Street, Westminster; Geo. Watson, A.M.I.C.E., 21, Springfield Mount, Leeds; Chas. E. A. F. S. Butler, 4, Princes Mansions, Victoria Mansions, Victoria Street, S.W., manager; Frank L. Watson, 21, Springfield Mount, Leeds, A.M.I.C.E.; Wm. Hillman, 7, Tolson Street, Leeds, engineer; Chas. F. Dent, 5, St. John's Terrace, Leeds, cashier; Joseph Williams, 38, Springfield Place, Leeds, clerk. The number of directors is not to be less than three nor more than seven; the first are Arthur Greenwood, Philip A. V. Robinson, Arthur P. James, George H. Denison, Morgan Lindsay and Geo. Watson; qualification, 500 shares; remuneration, £700 per annum, divisible.

West London and Provincial Electric Supply Company, Limited (62,097).—This company was registered on May 13th, with a capital of £150,000 in £1 shares (80,000 £6 per cent. cumulative preference), to adopt an agreement with T. Brooke-Hitching, and to carry on the business of an electric light company, and of electricians, electrical and mechanical engineers, suppliers of electricity and electrical apparatus manufacturers. The first subscribers (each with one share) are:—Henry Jenkins, 5, Henry Road, Finsbury Park, N., accountant; Griffith S. Salway, 39, Alma Square, St. John's Wood, N.W., secretary; Henry J. Slade, 12, Oaklands Grove, Uxbridge Road, W., salesman; Joseph Windsor, 18, Bodney Road, Hackney Downs, N.E., clerk; George H. Mathews, 1, Boxworth Grove, Barnsbury, N., writer; Herbert I. Bickerton, 25, Woodstock Road, Finsbury Park, N., clerk; George Haddock, 4, Gordon House, King's Cross, N., clerk. The first subscribers (to number not less three nor more than seven) are to be nominated by the subscribers; qualification, £200; remuneration, £1,200 per annum and a share in the profits, divisible.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Birmingham Electric Supply Company, Limited (30,296).—This company's annual return was filed on March 23rd, when the whole capital of £200,000 in £5 shares was taken up and paid for in full.

British Columbia Electric Railway Company, Limited (51,953).—This company's annual return was filed on February 14th, when 20,007 shares were taken up out of a capital of £250,000 in £10 shares; 20,000 shares are considered as paid, and £1 15s., or 5s. per share has been paid on the others.

Norwich Electricity Company, Limited (30,694).—This company's annual return was filed on March 17th, when the capital of £50,000 in £10 shares was fully taken up and paid.

Windsor Electrical Installation Company, Limited (46,186).—This company's annual return was filed on March 24th, when the whole capital of £25,000 in £1 shares was taken up; 450 shares are considered as paid, and £24,550 has been received on the others.

Wimshurst, Hollick & Co., Limited (41,466).—This company's annual return was filed on April 5th. The capital is £40,000 in £5 shares (4,000 preference). All the ordinary and 3,968 preference have been taken up; the ordinary are considered as paid, and £19,840 has been paid on the preference.

Wilson Manufacturing Syndicate, Limited (51,074).—This company's annual return was filed on March 28th, when 650 shares were taken up and paid for in full out of a capital of £2,000 in £1 shares.

CITY NOTES.

Calcutta Electric Supply Corporation, Limited.

THE annual general meeting was held on Friday at the Cannon Street Hotel, Colonel A. J. Filgate presiding.

In moving the adoption of the report, the CHAIRMAN remarked that the central station was nearly completed by the end of December, and it was reported that all the machinery had arrived in good order, and that its erection had been carried out satisfactorily. In the matter of constructing the mains the action of the Government authorities had caused considerable inconvenience, as the materials for these could not be ordered until the nature of the mains had been determined. When this was finally settled the materials could not be obtained as quickly as was desired, owing to the manufacturers being full of work, and the actual supply of current to customers was consequently further delayed. The directors calculated that when the works commenced running on the 17th ult., there were 3½ miles of underground mains, and 10 miles of overhead mains in operation. The total lengths of sanctioned mains at the present time were about 7½ miles underground, and 17 miles overhead. Although the commencement of working had been unduly delayed, he thought that the shareholders might rest assured that a fair start had been made. There were still two 360-indicated horse-power steam sets under construction in England; one of these was nearly completed, and would be shipped at an early date. With these machines the company would probably be able to meet all demands on their system in the immediate future, but, judging from the report as to

the probable extensive use of fans in lieu of punkahs, it might be necessary for the board to consider an extension of the plant at an early date. They had been negotiating for some time with the Calcutta Municipality for lighting certain streets, but so far nothing definite had been arranged. They had also tendered to the Government for lighting Fort William; this tender was still under consideration. They had further quoted rates for working a portion of the lines of the Calcutta Tramway Company. It seemed possible that the commencement of the actual supply of electricity to the public might tend to bring some of these negotiations to a head. In the matter of private lighting and power the company's agents reported that consumers had at present come forward to the extent of about 2,000 lights, and they reported that many persons were only waiting to see the light in use before adopting it. Since the works had been started applications had been received for the supply of current to Government House and the adjacent buildings, involving the supply of the equivalent of about 1,800 8-candle-power lamps. The company's consulting engineer, Mr. Crompton, an experienced expert, had been to Calcutta, and had returned greatly impressed with the prospects of the undertaking and the manner in which the works had been carried out. The directors were not satisfied as to the present position of the promise made by the Government of Bengal to renew the license at the expiration of the first period of 21 years if the undertaking was not then purchased by the municipality or the Government. The difficulty in meeting the directors' view of the promise made to them was apparently due to the fact that the exact wording of that promise was not in accord with the Calcutta Electric Lighting Act. Mr. Crompton had gone into this matter with the Viceroy and the Lieutenant-Governor of Bengal, and he (the chairman) had every hope that this question was in fair train for satisfactory disposal at no distant date.

Sir G. L Molesworth seconded the motion, which was carried unanimously after a few remarks from Mr. Crompton.

Giffre Electro-Chemical and Power Company, Limited.

The statutory meeting of this company was held on Wednesday at the offices of the company, when Mr. E. E. Sawyer, the chairman, gave some details of the position of the company. As shareholders knew, it was proposed to continue the French company, the English company holding most of the shares in it. They proposed to issue before the end of the year debentures for the purpose of acquiring the Giffre water-power instead of renting it. There had been some delay in making a start at the works, but they had now four turbines and dynamos representing 4,000-H.P., as well as seven furnaces, at work, and they could turn out 50 tons of carbide a week. By next January they would have doubled the output, but they might be delayed on account of the difficulty in getting early delivery of dynamos.

Stock Exchange Notices.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in:—Aron Electricity, Limited—125,000 6 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 125,000; Hiram S. Maxim Electrical Corporation, Limited—200,000 vendors' £1 shares, fully paid, Nos. 8 to 200,007 (special application); and to allow the following securities to be quoted in the Official List:—Smithfield Markets Electric Supply Company, Limited—12,000 ordinary shares of £5 each, fully paid, Nos. 1 to 12,000, and £50,000 4 per cent. debenture stock.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending May 13th, 1899, were £962 10s. 9d.; aggregate to date £4,722 18s. 6d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending May 12th, 1899, were £2,868 2s. 8d.; corresponding period, 1898, £2,648 6s. 7d.; increase, £214 15s. 8d.

The City and South London Railway Company.—The receipts for the week ending May 14th, 1899 were £926; week ending May 15th, 1898 £958; decrease, £32; total receipts for half-year, 1899, £21,279; corresponding period, 1898, £20,679; increase, £600. Miles open, 8½.

The Dover Corporation Electric Tramways.—The receipts for the week ending May 13th, 1899, were £154 10s. 6d.; week ending May 14th, 1898, £135 5s. 11d.; increase, £19 4s. 7d. Total receipts to date, 1899, £2,885 19s. 11d.; corresponding period, 1898, £2,217 8s. 7d.; increase, £668 11s. 4d. Miles of track open week ending May 13th, 1899, 8; week ending May 14th, 1898, 8. Car miles run week ending May 13th, 1899, 4,062; week ending May 14th, 1898, 3,257. Number of cars, week ending May 13th, 1899, 11; week ending May 14th, 1898, 7.

The Dublin United Tramways Company.—The receipts for the week ending Friday, May 12th, 1899, were as follows:—D. U. T. Co., horse cars, £1,854 10s. 9d.; ditto, electric cars, £1,180 13s. 5d.; D. S. D. Co., electric cars, £819 8s. 11d.; total, £3,804 8s. 1d.; corresponding week last year—D. U. T. Co., horse cars, £2,705 12s. 1d.; ditto, electric cars, £428 9s. 1d.; D. S. D. Co., electric cars, £545 14s. 8d.; total, £3,674 16s. 2d.; increase, £129 11s. 11d.; aggregate to date, £63,982 4s. 10d.; ditto last year, £60,744 4s. 4d.; increase to date, £3,238 0s. 6d. Worked:—The mileage open is 18 miles electrically, 26 miles by horses, as against 11 miles electrically, and 31 miles by horses, for the corresponding period last year.

The Liverpool Overhead Railway Company.—The receipts for the week ending May 14th, 1899, amounted to £1,339; corresponding week last year £1,446; decrease, £107.

The South Staffordshire Tramways Company.—The receipts for week ending May 12th, 1899, were £626 4s. 10d.; aggregate receipts for 19 weeks, £11,720 10s.; week ending May 13th, 1898, £606 9s. 6d.; aggregate receipts for 19 weeks, £11,267 11s. 2d.

STOCKS AND SHARES.

Wednesday Evening.

The Electric Lighting Share Market has been rather disagreeably surprised this week at the appearance of a seller of City of London shares. After trying all round the dealers to find a buyer at his price, the member was obliged to return disappointedly to his client, and in the meantime the quotation was marked down to 16½ in case he should reappear with a cheaper limit. There is no intrinsic reason for the fall in price, and at the time of writing nothing further has transpired with regard to the competition of the companies for electric lighting of the City. Metropolitans and St. James's are 17 and 17½ respectively, the same as they have been since the beginning of the month, and while Charing Cross at 11½ are equally immobile, Chelsea have improved to 8½; but fears of competition have been sufficient to reduce South London Electrics to 3¼, at which the price is ⅛ lower on the week.

The Electric Railway Market is alive with the new business in Central Londons. Since the company's Ordinary shares were introduced to the public in 1895, there has been a very limited market indeed up to the present time, but with the anticipated opening of a section of the line within a short time, has come a brisk demand for all classes of the shares. The prospectus stated that the contractors (the Electric Traction Company, Limited), for the lump sum of £3,244,000, would undertake to acquire the necessary land, construct and equip the railway, and hand over the line complete in every way for public traffic by June, 1899. Subsequently it was found necessary to postpone the construction of that part of the railway that lay between Liverpool Street and the Bank of England, so the contract price was lowered in proportion. The capital expenditure up to the end of last year was a trifle under 2½ millions sterling. Up to the present, shareholders have been receiving interest at the rate of 3 per cent. per annum, £150,000 having been set aside for that purpose, and the money will be practically exhausted by the end of next month. There is a strong feeling abroad, however, that the company will pay well from the start, and the patient shareholders are at last treated to a pleasurable premium on the shares. For our own part, we would advise shareholders to refrain from trying to grasp too much; a set back will probably occur before very long, and it is always a safe rule—for speculative investors at all events—to take their profits. Waterloo and City Ordinary is inclined to dulness at 108½, and City and South London cannot get over 70. Metropolitan Stock is weak at the renewed talk of the Great Central defection depriving the Underground line of a good deal of profit, and Metropolitan Districts are also dull, despite the special attractions that have lately been falling within the company's service.

There is a likelihood of coming activity in the market for shares of provincial tramway concerns, consequent upon the new schemes that are being pushed forward with regard to several of the companies. In Staffordshire they are talking of a big extension of the electric traction principle as applied to tramways, and we are inclined to think that at 15 Potteries Electric Traction shares are likely to become a remunerative investment, although, of course, dealing in them is very restricted. City of Birmingham Trams Preference have been quiet of late at 5½, but Blackpool and Fleetwood are well supported at 24 With regard to the Foreign Trams, Bordeaux are easier at 19½, Anglo-Argentines are 4½, *ex* the dividend of 2s. 3d., and it would not need much encouragement to bring about a rise in these shares.

Free dealings are taking place in the various issues of the Welsbach Incandescent Company upon the idea that at the forthcoming meeting an important announcement will be made in reference to the new electric patent which it is stated that the company has acquired. At 97 we consider the Deferred Stock a likely speculation. Amongst other miscellaneous financial items must be recorded the rise in local traction stocks in New York, consequent upon the modification of the Municipal Franchise Bill, and a report that the Exploration Company had completed its contract for electric trams in Paris led to a rise in these last to 2 7/8.

Telegraph issues are brightening up again, and Easterns have improved to 162½, or 4 up. Holders are becoming more reassured owing to Mr. Chamberlain's attitude on the new Pacific cable matter. Anglo-American "A" are ¼ better at 12⅞, while the "B" stock is unaltered at 111. Eastern Extensions have been bought, and a 5s. rise has taken place, the price is 16½. Eastern and South African Cable Debentures are quoted at 102, medium.

There has been a slight cessation of the buying which took place last week of shares in the telegraph manufacturing companies, but Telegraph Construction is a point to the good at 38, although Telegraph Manufacturing show no quotable change at 9⅞. Electric Constructions are 2¼, and Henleys remain steady at 25. British Electric Traction shares are ½ weak, closing to-night at 18½. Of the smaller things, Nernst Electrics are pursuing the path we anticipated, and had risen to 1/16 discount. Aron Meter Ordinary and Preference are both ⅞ middle.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation, May 10th.	Closing Quotation, May 17th.	Business done during week ended May 17th, 1899. Highest.	Lowest.
124,400£	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	101 —105	103¾	103½
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
905,560£	Anglo-American Telegraph	Stock	£2 13s	3 %	£3 9s	60 — 63	60 — 63	60½	60
3,047,220£	Do. do. 6 % Pref.	Stock	£5 6s	6 %	6 %	110½—111½	110½—111½	111⅝	110½
3,047,220£	Do. do. Deferred...	Stock	...	...	18s. %	12½— 12¾	12½— 13	12⅞	12 1/16
205,151	Brazilian Submarine Telegraph	10	7 %	7 %	...	15¼— 15¾	15½— 16	15⅞	15⅝
75,000£	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	110 —114	110 —114	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2½— 3	2½— 3	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	8 %	185 —195	185 —195	...	...
1,332,523£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	104 —106	104 —106	105½	105⅛
224,850	Consolidated Telephone Construction and Manufacturing	10/-	2 %	1½ %	...	⅛— ¼	⅛— ¼	...	...
16,000	Cuba Telegraph	10	8 %	7 %	8 %	9 — 10	9 — 10	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½— 19½	18½— 19½	18 15/16	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	9½— 10½	9½— 10½	...	...
30,000£	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½ %	4½ %	...	106 —109%	106 —109%	...	...
60,710£	Direct United States Cable	20	3 %	3½ %	...	11 — 11½	11 — 11½	11½	11 7/16
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	102 —105	102 —105	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	6½%	7 %	...	156 —161	160 —165	164	157
1,795,000	Do. 3½% Pref. Stock	100	...	...	...	100 —104	100 —104	102½	100½
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	...	101 —104	101 —104	...	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	119 —123	119 —123	120	119½
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	16 — 16½	16¼— 16¾	16⅝	16⅛
16,200£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	...	100 —104	100 —104	...	...
64,400£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	...	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	121 —125	121 —125	121	...
35,100£	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	...	...	100 —104	100 —104	100½	...
46,500£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	...	...	101 —104	101 —104	...	...
300,000£	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	...	...	102 —105	102 —105	102¾	102⅜
200,000£	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	...	...	102 —105%	102—105%	102	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	5½ %	11½— 12	11½— 12	11⅝	11 1/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	15½— 16	15½— 16	15⅞	15 11/16
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	...	30½— 31½	31½— 32½	31⅝	...
92,600	Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	101 —104	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	57 — 60	55 — 58 xd	55½	55
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	...	108 —111	108 —111	...	...
490,000	National Telephone, 1 to 490,000	5	5½ %	6 %	6 %	4½— 5	4½— 5	4 3/16	4⅜
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	11¼	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4¾— 5¼	4¾— 5¼	...	...
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	99 —102	99 —102	100½	99½
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅞— 1	⅞— 1	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	...	7 — 8	7½ — 8½	7¾	...
3,381	Submarine Cables Trust	Cert.	...	...	...	127 —132	130 —135	129½	...
58,000	United River Plate Telephone	5	5 %	6 %	...	4¾— 5¼	4¾— 5¼	...	...
151,733£	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	104 —107	...	...
200,000£	West African Telegraph, 5 % Debs.	100	5 %	5 %	...	99 —102	99 —102	100	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	103 —106	103 —106	...	...
389,521	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	106 —109	...	...
88,321	West India and Panama Telegraph	10	1 %	2%	...	2 — 2¼	2 — 2¼	2⅛	2
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	...	10¾— 11¼	10¾— 11¼	11⅛	10¾
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	...	9 — 10	9 — 10	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	...	105 —108	105 —108	...	...
158,100£	Western Union of U.S. Telegraph, 6 % Ster. Bonds ...	100	6 %	6 %	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	6 %	7 %	8 %	11 — 12	11 — 12	11 7/16	11 3/16
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	5⅜— 6¼	5⅜— 6¼	6 3/16	6⅛
34,000	*Chelsea Electricity Supply, Ord., ...	5	5 %	6 %	6 %	7½— 8½	8 — 9	8⅝	8 5/16
100,000	Do. do. do. % Deb. Stock Red....	Stock	4½ %	4½ %	...	114 —116	114 —116	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000 ...	10	7 %	10 %	6 %	17 — 18	16½— 17½	17¼	16½
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15 — 16	15 — 16	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	124 —129	125 —130	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	*nil*	*nil*	11 — 12	11 — 12	11 3/16	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	14 — 15	14 — 15	14½	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	5 %	...	5⅛— 5⅜	5⅛— 5⅜	5 7/16	5⅜
19,661	House-to-House Electric Light Supply, Ord., 101 to 19,661	5	...	4 %	6 %	8½— 9½	8½— 9½	...	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	...	9 — 10	9 — 10	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	3½— 3¾	3½— 3¾	3½	...
48,5	Do. do. do. 6 % Pref.	5	...	...	6 %	6½— 7	6½— 7	6¾	...
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	106 —108	106 —108	105½	...
62,500	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	5 %	16½— 17½	16½— 17½	17⅛	16¾
22,500	Do. Nos. 62,501 to 85,000]	10	...	...	...	15½— 16½	15½— 16½	...	...
220,000£	Do. 4½ % First Mortgage Debenture Stock	...	4½ %	4½ %	...	118 —121	118 —121	...	...
6,452	Notting Hill Electric Lighting	10	4 %	6 %	6 %	16½— 17½	16½— 17½	...	...
31,980	St. James's and Pall Mall Electric Light, Ord.	5	10½ %	14½ %	14½ %	17 — 18	17 — 18	17⅛	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	9¼	...
65,000	South London Electricity Supply, Ord., £3 paid	5	...	...	...	3½— 3¾	3½— 3⅝	3⅝	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	9 %	12 %	12 %	14½— 15½	14½— 15½	...	...

* Subject to Founder's Shares.
Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
‡ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation May 10th.	Closing Quotation May 17th.	Business done during week ended May 17th, 1899. High est	Lowest
60,000	Aluminium "A" shares, Nos. 1—60,000	1	10 %	10 %	...	3 — 3½	3 — 3½	3 1/16	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	95 —100	95 —100	...	...
30,000	British Electric Traction	10	...	...	6 %	18½— 19½	18 — 19	18⅝	18 7/16
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	14 — 14½	13¾— 14¼	14 3/16	14
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	126 —129	126 —129	128¾	127½
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	*nil*	*nil*	...	1⅞— 2⅛	1⅞— 2⅛	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	*nil*	4 %	...	2¼— 2½	2¼— 2½	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	10 %	12½%	...	12¾— 13¼	12¾— 13¼	...	...
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	114 —117	114 —117	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	10½— 11	11 — 11⅛	11⅛	10⅞
178,303	Do. do. do. £8 paid	10	...	...	...	8½— 9	9 — 9⅛	9⅛	9⅛
61,033	Do. do. Pref. half-shares £3 paid ...	...	...	...	...	3¼— 3¾	3¼— 3¾	3⅝	3½
71,447	Do. do. Def. do. £5 paid ...	...	...	...	...	5½— 5¾	5¾— 6¼	6⅜	5 13/16
630,000*l*	City and South London Railway	Stock	1 9/16 %	1⅞%	2⅛%	68 — 70	68 — 70	69	...
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £5 pd.	10	...	...	...	4¾— 5⅛	4¾— 5¼	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	3¼— 3¾	3½— 4	...	...
100,000	Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	...	...	...	...	98 —101	98 — 101	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5½%	6 %	...	2 — 2⅛	2 — 2⅛	2 1/16	2⅛
17,139	Do. do. do. "A" Shares, 01—017,139	5	5½%	6 %	...	4 — 5	4 — 5	...	...
344,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	96 — 98	96 — 98	97¾	97½
112,100	Electric Construction, 1 to 112,100	2	5 %	6 %	6 %	2⅛— 2⅜	2⅛— 2⅜	2 1/16	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	3 — 3⅛	3 — 3⅛	3⅛	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	103 —106	103 —106	105½	104½
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	⅝— ⅞	⅝— ⅞	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	...	10 — 12	10 — 12	...	...
15,000	Henley's (W. T.) Telegraph Works, Ord.	10	10 %	12 %	14 %	24½— 25½	24½— 25½	25⅜	25
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18 — 20	18 — 20	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	4½%	...	112 —115	112 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21½— 22½	21½— 22½	22⅛	21½
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	101 —105	101 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2½%	3½%	3½%	9⅛ — 9⅜	8⅝— 8⅞	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	14⅜— 14⅞	14⅜— 14⅞	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	35 — 39	36 — 40	38¾	37¾
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	105 —108	105 —108	...	...
13,400	Telegraph Manufacturing, Ord. Nos. 6,601 to 20,000 ...	5	...	...	...	9½— 10	9¼— 10	9 1/16	...
13,400	Do. do. 5% Cm. Prf. Nos. 6,601 to 20,000	5	...	...	...	5¾— 6¼	5¾— 6¼	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	3 %	108 —111	107 —110	...	...

† Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10⅛.
British Aluminium, Ordinary, 10½—11; 7 % Pref., 12—13.
House-to-House, 4½% Debentures of £100, 105—108.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6%, £5 (fully paid), 7½—8. Debentures, 107—110. Dividend, 1898, on Ordinary Shares 10%.
National Electric Free Wiring, 10s. paid, 6s.—8s.
Smithfield Market Electric, 3—4.
*T. Parker, £10 (fully paid), 16.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (February 2nd, 1899).

MARKET QUOTATIONS, Wednesday, May 17th.

CHEMICALS, &c.	This week.	Last week.	Increase.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a „ Nitric .. .. .. per cwt.	22/-	22/-	..
a „ Oxalic .. .. .. per cwt.	32/-	32/-	..
a „ Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per cwt.	37/-	37/-	..
a Ammonia, Muriate (crystal) .. per ton	£26	£26	..
a „ „ .. .. per ton	£24	£24	..
a Bleaching powder .. .. per ton	£5 15	£5 15	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. .. per ton	£16 10	£16 10	..
a Benzole (90 %) .. .. .. per gal.	7/-	7/-	..
a „ (50/90 %) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£26 15	£26 10	5s. inc.
a Lead, Nitrate .. .. .. per ton	£23 10	£23 10	..
a „ White Sugar .. .. .. per ton	£30 10	£30 10	..
a „ Peroxide .. .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	3¾d.	3¾d.	..
a „ Caustic (75/80 %) .. per ton	£24	£24	..
a „ Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	68/-	68/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6 15	£6 15	..
a „ Recovered .. .. per ton	£5 15	£5 15	..
a „ Lump .. .. .. per ton	£5 5	£5 5	..
a Soda, Caustic (white 70 %) .. per ton	£7 10	£7 10	..
a „ Crystals .. .. .. per ton	£3	£3	..
a „ Bichromate, casks .. per lb.	3d.	3d.	..
METALS, &c.			
b Aluminium Wire, in ton lots .. per ton	£224	£224	..
b „ Sheet, in ton lots.. per ton	£191	£191	..
p Babbitt's metal ingots .. .. per ton	£65 to £157	£65 to £137	..
c Brass (rolled metal 2" to 12") basis per lb.	8¼d.	8¼d.	..
c „ Tube (brazed) .. .. per lb.	10¼d.	10¼d.	..
c „ Wire, basis .. .. per lb.	8¼d.	8¼d.	..

METALS, &c. (*continued*).	This week.	Last week.	Increase or Decrease.
f Ebonite Rod .. .. .. per lb.	3/-	3/-	..
f „ Sheet .. .. .. per lb.	5/-	5/-	..
g Copper Bars .. .. .. per ton	£80	£80	..
g „ Wire (basis price) .. per lb.	10½d.	10½d.	..
g „ Sheet .. .. .. per ton	£80	£80	..
g „ Rod .. .. .. per ton	£80	£80	..
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	6/-	6/-	..
h India-rubber, Para fine .. per lb.	4/1½	4/3	1½d. dec.
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i „ Pig (Cleveland warrants) per ton	55/5½	54/10½	7d. inc.
i „ Forgings, according to size per ton	From £11	From £11	..
i „ Scrap, heavy .. .. per ton	50/- to 55/-	50/- to 55/-	..
i „ Wire galvanised No. 8 .. per ton	£10 2 6	£10	2/6 inc.
g Lead, English Ingot .. .. per ton	£14 12 6	£14 12 6	..
g „ „ Sheet .. .. per ton	£15 10	£15 10 0	..
l Mica (uncut slabs 8" long) .. per lb.	6/8	6/6	2d. inc.
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£8 5	£8 5	..
p Phosphor Bronze, plain castings per lb.	1/1 to 1/4	1/1 to 1/4	..
p rolled bars & rods per lb.	1/1 to 1/4	1/1 to 1/4	..
p „ r'l'd strip & sheet per lb.	From 1/2½	From 1/2½	..
o Platinum .. .. per oz.	£3 10	£3 10	..
p Silicium Bronze Wire .. .. per lb.	10½d. to 1/1	10½d. to 1/1	..
i Steel, Magnet, acc'd'g to desc'p'n p. ton	From £15	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£115	£115	..
g „ foil .. .. per lb.	1/6	1/6	..
n „ wire Nos. 1 to 16 .. .. per lb.	1/7	1/7	..
p White Anti-friction Metals— "White Ant" brand .. per ton	£40 to £65	£40 to £65	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	7½d.	7½d.	..
j „ Flax, 6 or 8 lea... .. per lb.	4d.	4d.	..
j „ Hemp, 8 ply 10 lbs. .. per lb.	3½d.	3½d.	..
j „ „ Russian, 10 lbs. per lb.	4½d.	4½d.	..
j „ Jute, 180 lbs. rove .. per ton	£12	£12	..
j „ Manila, 24 thread .. per ton	£32 10	£32 10	..
k Zinc, Sheet (Vielle Montagne bnd.) p.t.	£31 10	£31 10	..

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d
e
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry C. Yeo & Co.
k Messrs. Morris Ashby, Limited.
l Messrs. Sanders, Wake & Co.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

MAGNETISM.*

By Prof. JAMES ALFRED EWING, F.R.S., M.I.C.E.

When the Council of the Institution honoured me with an invitation to deliver the "James Forrest" lecture they suggested "Magnetism" as the subject. I felt at the time that it was like prescribing an ox roasted whole for an invalid's lunch. How could one treat a theme so vast within the limits of a single hour with any hope of making it pleasing or even digestible? But, having nothing better to propose, I weakly acquiesced, and I now find myself confronted by this appalling task. It gives me at least a grain of comfort to reflect that the Council must take a large share of responsibility for the choice.

Whatever be his subject, the particular duty of the "James Forrest" Lecturer is to treat it as an illustration of the bearing of science upon practice. He has to show how the visions of the philosopher become translated into the matter of fact of the engineer; how observations and theories which at first awaken only the intellectual interest of the scientific enthusiast are in time found to have application to the use and convenience of the man in the street. He has to show that if necessity is the mother of invention, science is often its foster-mother. And there is another side to the matter, for if the lecturer discharges his duty aright he will show how practice pays back its debt to science; how the progress of invention stimulates the progress of discovery; how the laboratory owes as much to the workshop as the workshop owes to the laboratory.

Time was when it might have been appropriate in addressing an audience of engineers to plead for the better recognition of science as the handmaid or mistress of practice. But there is no need to do that now. The service which each does to the other is recognised; the beneficent reaction between them has, in late years especially, been too fruitful to escape universal notice. Whatever barrier used to be apparent has broken down. Day by day, one may say, more and more points of contact are found, more grounds of sympathy in sentiment, more opportunity for co-operation. To one who, like your lecturer, has his affections distractingly divided between physics and engineering it is pleasant to note that not simply in education, but in language, in mental habit, in appreciation of experiment and in many other ways, engineers become daily more and more akin to physicists, while students of natural science grow more ready and more able to observe nature from the standpoint of the engineer. There will always, we need not doubt, remain two extreme schools of intellectual activity, one caring only for abstract truth, the other with no interest save for what promises immediate application. But between those extremes you will find men of more catholic spirit, whose zest for scientific discovery is none the less keen because they have an eye to the uses to which some of it may be put. The achievements in the world of practice of a Kelvin or a Hopkinson are as remarkable as their discoveries in pure science. I mention great names, but there are many lesser men who follow in their footsteps.

Certainly it would be difficult to find a subject that is better fitted to illustrate the harmony of practice and science than this subject of magnetism. Indeed, so intimate is their contact and co-operation here that it would be hard, in giving any account of the subject, to draw a line between matters of industrial application and fruits of research.

The applications of magnetism are older than the science—so old that they are lost in the mists of the remote past. If we cast our eyes far enough back they light on the traditional and shadowy figure of the Chinese imperial navigator Hoang Ti, who, some 24 centuries before Christ, is said to have piloted his fleet of conquering junks by the aid of a floating fragment of loadstone. The loadstone, a natural magnet composed of the magnetic oxide of iron, is found in the magnetised state at many places on the earth's surface, and notably at Magnesia, in Asia Minor, which led Euripides to call it the magnetan stone. Though the writings of Plato and Pliny and Lucretius contain many references to the distinctive properties of the loadstone and many curious legends concerning it, it is remarkable that neither the Greeks nor the Romans were aware of its use in navigation. We are told in the Book of Acts that St. Paul, after staying three days at Syracuse, "fetched a compass" and came to Rhegium, but any student of the Institution will tell you it was not a mariner's compass that he fetched.

Though the uses of magnetism were unknown in those classical times, its abuses appear to have flourished then, as they do still. The loadstone was reputed to free women from witchcraft and to put demons to flight. A magnet pickled with the salt of the sucking-fish could draw water from the bottom of the deepest well. Iron rings magnetised by rubbing against a loadstone were a remedy for the gout, and the priests of Samothrace, five centuries before the Christian era, are said to have made a tidy revenue by selling those ancient prototypes of the modern magnetic belt. The mysteries of magnetism have in all ages formed a happy hunting ground for lovers of the occult. Quackery and superstition have found it a name to conjure with. The fact that a thing is unintelligible has been held sufficient reason for dubbing it magnetic. It is no part of my business to speak of "Animal Magnetism," for whatever elements of fact there are in the reported phenomena which go by that name, we may rest assured that with magnetism they have nothing whatever to do. It is a striking fact that among our bodily senses we have nothing to help us to a perception of magnetic activity. The sense of sight may indeed be called a magnetic sense when regard is had to the principle that light is made up of electro-magnetic waves, but you may put your hand or your head between the poles of the most powerful magnet and be unable to tell whether the magnet is or is not in action. We have no direct perception of the magnetic field, and there is no such thing in any legitimate use of the term as animal magnetism.

According to one story, it was Marco Polo, the Venetian, who brought the mariner's compass from China to Europe in the 13th century. Anyhow, its use was known then, though the attractive influence was wrongly localised, being ascribed to one of the stars in the tail of the Great Bear. The Provençal poet, Guiot, in a MS. of the 13th century, tells at length, as if it were rather a new thing then, how a steel needle may be magnetised by touching it with a loadstone, and how, when put through a piece of straw and set floating it always points to the north:—

"Puis se torne la point toute
Contre l'estoile sans doute."

A famous letter of Peter Peregrinus, written in 1269, contains a remarkably good account of the polar quality of the magnet, and of its use in finding the north. By the time of Columbus the compass, with its divided card, was apparently a common appliance in navigation. It was during his first voyage to America in 1492 that Columbus discovered the variable deviation of the needle from the true north. The fact that the balanced needle does not lie horizontally, but dips, was discovered by a London instrument maker called Norman in 1576.

We may take it, then, that applications of magnetism were known certainly 600, perhaps 5,000 years ago. But the science of magnetism is just 300 years old; it dates from the publication, in the year 1600, of the treatise "De Magnete," by William Gilbert. In that remarkable book the speculations of the schoolmen and the "old wives' tales" which had gathered about the subject were brushed aside, and the foundations of magnetic philosophy were laid on the safe ground of experiment. Gilbert showed, by means of a model globe cut out of loadstone, that the behaviour of the compass needle was to be explained by regarding the earth itself as a great magnet, surrounded consequently by an *orbis virtutis*—a sphere of influence, or, as we should now call it, a magnetic field. Time would fail me to tell you of the many acute observations described by Gilbert, which entitle him to high rank among the founders of experimental science. Galileo, his even greater contemporary, said: "I extremely admire and envy the author of 'De Magnete,'"; and Dryden wrote this panegyric:—

"Gilbert shall live till loadstones cease to draw,
Or British fleets the boundless oceans awe."

This last line suggests the remark that if Dryden could see the naval estimates for the present year of grace—and of aspiration after general disarmament—he would surely have no misgivings as to the permanence of Gilbert's fame.

It would be easy to occupy the whole of the lecture in telling of the subsequent developments of that first application of magnetism, the mariner's compass; of the new problems which presented themselves when magnetisable metals, iron and steel, took the place of timber in the construction of ships; of the analysis by Archibald Smith of the various disturbing influences which the magnetism of the ship exerts; and of the inventions by which Lord Kelvin brought the compass to its present state of perfection and enabled correcting devices to be applied by which the effect of the ship's magnetism are neutralised. In Lord Kelvin's compass we have a striking instance of the results that are achieved when profound scientific insight works hand in hand with rare practical instinct and inventive skill. I wish I could dwell on so attractive a theme, but I must hasten on to speak of other developments and applications of the science of magnetism.

The pivoted needle of the compass turns so that it may place itself in the direction of the lines of force of the magnetic field; so long as no local disturbing cause acts, the field is that due to the magnetism of the earth. But Oersted discovered, in 1820, that if a wire conveying an electric current were brought near, the needle became deflected, because (as we now know) the current produces a magnetic field on its own account, whose lines of force encircle the conducting wire. Eleven years later Schweiger showed how this effect could be intensified by winding the conductor into a coil, in the middle of which the pivoted needle was set, and thereby invented the galvanometer. The laws of the phenomenon were investigated by Ampère and by Weber, and thus the way was paved for the introduction in 1837 of the needle telegraph by Cooke and Wheatstone. Our president has lately told us of their pioneer line 1½ miles long, part of which was revived by him and was used, as a relic of the year of the Queen's accession, to telegraph Her Majesty's message to her scattered peoples on the day of her Diamond Jubilee. What that lusty infant, the telegraph, has grown to in the intervening 60 years you do not need to be told. Taking British telegraphs alone, the expansion of which owes much to our president's fostering care, there are now considerably more than 1,000,000 miles of wire. Our distant colonies are bound to the mother country not simply by links of loyalty and mutual affection, but by material bonds of copper which have no small part to play in the building up of Empire.

The suspended needle, by which Cooke and Wheatstone gave practical application to the discovery of Oersted, did not long remain the sole, or even the chief, instrument in telegraphy. It was almost at once supplemented, and soon to a great extent displaced, by the family of instruments which depend on the attraction which an electro-magnet exerts on a movable armature, instruments of which the telegraph of Morse was the first to take working shape. But Oersted's discovery met with a second great application at the hands of Lord Kelvin in 1858, when the problem of signalling at a remunerative speed through long ocean cables was solved by his invention of the mirror galvanometer, an invention which, at the same time supplied physicists with an invaluable new weapon of research. His later invention of the siphon-recorder allowed the delicate fluctuations of current, which constitute the signals in such a cable, to be registered as well as read. In the galvanometer the coil is held fixed and the

* Institution of Civil Engineers, James Forrest lecture.

magnet moves. In the Kelvin recorder the force between the two is still the operative force, but it is the coil that moves while the magnet is held fixed.

Morse's telegraph was the practical fruit of the discoveries of Ampère and Sturgeon. Ampère had shown that pieces of steel might be permanently magnetised by placing them inside a coil of wire, within which a magnetic field was established by passing an electric current through the wire. Sturgeon, in 1825, substituted a soft-iron core for the steel, and pointed out that it acquired strong magnetism so long as the current flowed through the surrounding coil, but lost its magnetism when the current ceased to flow. On establishing the current the iron core underwent, as he says, a "transition from a state of total inactivity to vigorous polarity," and exhibited "an intensity of action far surpassing that of any known permanent magnet." Joseph Henry improved the winding of Sturgeon's electro-magnet and used it, by means of a movable armature, to sound a bell at a distance from the operator. From this the step was easy to the recording telegraph of Morse. Simplified into the "sounder," this remains one of the most ordinary appliances of the telegraphist, and the principle it embodies finds application in the Wheatstone automatic receiver, in the type-printing telegraph familiar to those who study the "tape," and in a host of other forms.

Faraday's discovery, made in 1831, that a current of electricity is induced in a conducting circuit when it is moved in a magnetic field, in such a way as to vary the number of lines of force which it encloses, led to the invention of the magneto-electric machine, where the movement of the armature of a permanent magnet is used to induce currents in a coil. This has found many uses. It was applied in telegraphy by Wheatstone as the transmitting device in his step-by-step or A B C apparatus. Substantially the same principle formed the basis of the original telephone of Graham Bell. There the movement of an iron disc by the speaker's voice induced corresponding currents in a coil, through the agency of a magnet to which the disc acted as armature, the movements of the disc having the effect of varying the magnetic field within the coil. These currents passed to the distant end and gave rise to corresponding movements on the part of a second disc, in an instrument which was an exact counterpart of the first. I was old enough in 1876 to appreciate the charm of this weird and exquisite invention, and looking back now, it seems, as it seemed then, alike in its novelty, in the vastness of its consequences and in the simplicity of its means, to be the most marvellous of all the wonder-compelling applications of magnetism. The magneto-electric method of generating telephone currents, introduced by Bell, gave place, in the hands of Edison and Hughes, to other and better means, but the receiving portion of the apparatus retains substantially the form which he gave it. The varying attraction for its armature of a magnet which is strengthened and weakened by the transmitted currents is still used to cause the vibrations of the disc which convert those currents into speech. The latest advance in telegraphy, the achievement of Marconi in communicating between France and England without an intervening wire, is as much as any other a direct fruit of magnetic research. When an electric current comes into existence the magnetic field which it induces around it does not spread through space instantly but with a limited velocity. A current undergoing rapid oscillations, such as a discharge surging back and forth between two plates, consequently sets up magnetic waves of correspondir g frequency which travel out into space with a velocity which is, in fact, the velocity of light. These waves of magnetic induction were pictured by the mathematical imagination of Maxwell, and they were demonstrated by the experiments of Hertz, who showed us how to detect their presence at points which might be fairly distant from the source. The researches of Branly and Lodge gave far more delicate means than Hertz had used to discern the arrival of these magnetic waves; and Lodge, who has devoted much attention to the subject, has also been successful in developing appliances for sending and receiving signals over long distances by comparatively long-period waves of magnetic induction, using closed circuits at each end of the system, tuned into electric synchronism, so that the magnetic oscillations sent out by one of them are detected by aid of electro-magnetic resonance in the other. But the most striking success which has been achieved in this application of magnetism is Marconi's use of short-period Hertzian waves to signal across the Channel from the South Foreland to Boulogne. Mr. Marconi is to be warmly congratulated on accomplishing this remarkable feat, which has arrested the attention alike of the public and of specialists, and has opened all eyes to the practical capabilities of this new telegraphy.

It is interesting to note in passing, though it is scarcely relevant to my subject, that telegraphy by waves of magnetic induction is the oldest telegraphy of all. Maxwell's conclusion that the waves which constitute light are nothing less than very quick-period waves of magnetic induction was abundantly verified by the work of Hertz, who succeeded in submitting artificial magnetic waves to the reflection, refraction, and polarisation, which we are familiar with in the case of light. Hence the heliograph, the venerable semaphore, and all the visual signals that have been used from the day when Eve first smiled to Adam, are examples of magnetic wave telegraphy, though I cannot claim them as fruits of magnetic research. In the use of that most delicate of electro-magnetic receivers, the eye, we must admit that practice came before science.

Faraday's great discovery of the induction of electric currents by moving a conductor in a magnetic field of force led, as we have seen, to the magneto-electric machine. A permanent steel magnet served to produce the field, and the coils in which current was induced were generally wound upon an armature, which revolved between the poles. The early machines of Clarke and Pixii were improved upon by Wilde, who used a second machine to generate a current which was employed in magnetising the field magnets of the first. From this to the invention of the dynamo was a step so natural that we need not wonder it was taken independently, and almost simultaneously, about the beginning of 1857, by no fewer than three inventors, Wheatstone, Werner Siemens, and Alfred Varley. Up to that time the magneto-electric machine, when considered from the engineer's standpoint as an engine for producing electrical energy by the expenditure of mechanical work, had been little more than a toy. But the abolition of permanent magnets and the substitution of soft-iron cores excited by the current generated in the machine itself, constituted a revolution, and the dynamo became a means of applying power to generate electric currents on a grand scale. I do not mean that the change came all at once; it is a far cry from the "'A' Gramme" of 20 years ago to the big dynamos of to-day, with their 2,000 H.P. or 3,000 H.P. But the introduction of the self-exciting field magnet was the decisive step which made the mechanical production of electric currents a part of engineering—a large part, indeed, as it has since become.

(To be continued.)

DIRECT AND ALTERNATE CURRENT DISTRIBUTION.*

By H. H. WILLIAMS, Student.

(*Concluded from page* 702.)

Now in the central portions of a large city the consumers are very close together, the demand is very large, and is also that required for very many different purposes. Therefore, it is very likely that a great number of consumers prefer 100 volts, others 200 or 300, while others require 400 volts.

In such a case as this a five-wire system of distribution can be used to great advantage, since a consumer can then be supplied at any of these pressures. The pressure between the outers on a five-wire system is 400 volts. Diagrams A, B and C, show the pressures between the different poles and to which a consumer may be connected on the three and five-wire systems.

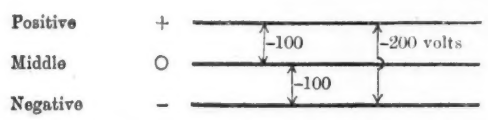


Diagram A.—Three-Wire with 200 Volts on the Outers.

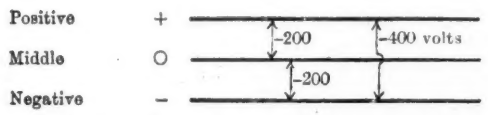


Diagram B.—Three-Wire with 400 Volts on the Outers.

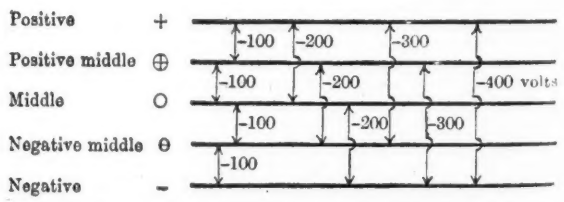


Diagram C.—Five-Wire with 400 Volts on the Outers.

I now wish to draw your attention for a few minutes to the second method of supply which I mentioned earlier on in my paper; and it is that case in which we have no choice but to adopt an alternating current system. The supply of electrical energy on the alternating system is a more difficult problem to face than if the supply were continuous. For instance, in continuous current systems the useful power is directly equal to the product of the amperes and volts. But in the alternating current system, the useful power is not equal to the product of the virtual amperes and virtual volts unless the current is in phase with the electromotive force.

In all alternating current supply circuits there is a considerable amount of apparatus, such as motors and transformers, having inductance, which causes the current to lag after the E.M.F. In an inductive circuit the product of the virtual amperes and virtual volts would only give us the apparent power and not the true or effective power. The effective power in this case is considerably less than the apparent power.

The effective power = virtual volts × virtual amperes × cosine angle of lag.

Now cosine 0° = 1.

* Paper read before the Students' Section of the Institution of Electrical Engineers on Wednesday, March 1st, 1899.

Consequently you see that only when the lag is zero is the effective power equal to virtual volts × virtual amperes.

The ratio $\frac{\text{effective or true power}}{\text{apparent power}}$ is called the power factor.

It is the aim of all central station engineers to get a power factor as nearly equal to unity as possible.

The power factor is only unity when the current is in phase with the E.M.F., *i.e.*, when the circuit contains no self-induction.

The effect of capacity is to cause the current to lead before the E.M.F., an effect which is directly opposite to the effect of inductance. Therefore, if we have inductance and capacity in the circuit in equal quantities the power factor of that circuit will be unity.

Therefore in central station work the power factor could be brought nearer to unity by the introduction of some apparatus having capacity, such as condensers. I do not think such an introduction has occurred in actual practice.

As I have said before, we may divide an electric supply undertaking into three main divisions, viz, generation, distribution, and consuming devices.

As regards generation, there can be no doubt that a direct driven plant is much to be preferred to either a belt or rope driven, owing to the economy of floor space and the higher efficiency obtained.

Generation by means of an alternator is accomplished without the use of a commutator; consequently, the current can easily be generated at high pressures, which practice is generally adopted in alternating current stations.

Mains constitute distributors and feeders. Low tension distribution in alternating current stations is very seldom done, owing to the fact that it is impossible to use cables of large sectional area. It, however, can be used if the area of supply is very small, and there is very little demand.

In an alternating current transformer current is supplied at high tension to the primary, which induces a larger current at a lower pressure in the secondary. In it there are no moving parts whatever; it requires no attention, takes up very little room, and is very efficient. Consequently, such a piece of apparatus can very conveniently be placed in either street boxes or on consumers' premises.

These transformers are used in connection with the high tension distributors, in order that a consumer may be supplied at low pressure. By this method a consumer may be supplied at almost any pressure he requires, provided, of course, that it is within the limit of the Board of Trade regulation.

In all alternating current stations high pressure feeders are used, the pressure being transformed down by the use of transformers placed in sub-stations or street boxes. If the area of supply is large, it should be divided up into districts. A transformer sub-station should be placed in each district. These sub-stations should be connected together by means of high pressure cables so that, in the event of a feeder to any district breaking down, that district can still be supplied simply by switching it on to the other sub-stations.

In cases where there has been a number of public arc lamps to be supplied, the tendency of the engineers seems to have been to use rectifiers in preference to either fixing shades over each lamp, or running a separate continuous current arc lighter.

I refer to this use of rectifiers later on when considering the relative advantages and disadvantages of direct and alternate current systems

At present there are 74 supply stations in the United Kingdom running on the alternate current system.

Since we may look upon a feeder as a medium by which power is transmitted from the generating station to the distributing network, I do not think I shall be departing from the subject of my paper if I say a few words in relation to multiphase currents, especially when we remember that the greater part of the power from the generating plant at Niagara is carried to the various districts of supply by a three-phase transmission plant.

In an ordinary single-phase alternator the armature is wound so as to generate a single current at any required pressure. But in a multiphase generator the windings on the armature are so arranged that it generates two or three distinct currents at the required pressure.

In a two-phase generator the currents differ in phase 90°, and a three-phase generator generates its three distinct currents differing in phase 120°.

Due to the ease with which transmission by multiphase currents can be effected at very high pressures, this system is decidedly superior to continuous current transmission, and in cases where the districts to be supplied are situate at some little distance from the generating station, a system of multiphase feeders can be used to great advantage.

Mr. Wordingham is adopting a system of multiphase feeders at Manchester to supply those districts which are very remote from the central generating station. Rotary converters are to be employed at the generating station to change the low pressure continuous current into high pressure alternating.

A similar arrangement is to be fixed at the feeding centre in order to transform the current from high pressure alternating to low pressure continuous.

I now come to perhaps the most important part of my paper, viz:—The relative advantages and disadvantages of direct and alternating systems of electricity supply. But since I have already occupied your attention for a considerable time I must make my remarks as brief as possible.

Practically speaking, the demand for electricity is that required for either:—

1. Incandescent lighting.
2. Arc lighting (public and private).
3. Motors.
4. Cooking and heating.
5. Electro-chemical apparatus.

The demand for electricity for cooking and heating purposes is so very limited (on account of the great cost) that I will not refer to the advantages and disadvantages of the two systems in this case.

Undoubtedly the requirements of the electro-chemical industry can only be met by continuous current.

There is an advantage in the use of alternating current for incandescent lighting, in that if you wished to lower the light, so to speak, an arrangement called a choking coil can be used; which piece of apparatus absorbs practically no energy. Whereas, in order to lower the light on a continuous supply a resistance would have to be inserted in series with the lamp in order to lower the voltage at the lamp terminals, an operation which is very objectionable, due to the great waste of energy in the resistance so inserted.

Arc Lamps.—Practically the whole of the light from an arc lamp proceeds from the crater. In a continuous current arc lamp the crater is formed on the positive carbon; therefore this carbon is made the top one, this causing the light to be thrown downwards, in which case practically the whole of the light is useful.

In an alternating current arc lamp the light is emitted from both carbons, which in shops may be used to advantage.

But for street lighting, unless it is the wish to light the heavens as well as the roadway, a shade is fixed over each lamp. Now, it is claimed that by this arrangement the light is more evenly distributed; but, at all events, a great percentage of the light is lost.

For street lighting there should be a crater on the top carbon, which, of course, cannot be achieved in an alternating arc lamp. The fact that, in places where they have an alternating station, rectifiers are used for arc lighting is in itself sufficient proof of the inadequacy of alternating current for arc lighting.

In a paper on "The Use and Economies of Rectifiers for Arc Lighting" read before the Northern Society of Electrical Engineers in May, 1896, Mr. Hesketh said: "The alternating current arc lamp is not so efficient as a generator of light as the continuous current arc." At that time Mr. Hesketh was the chief engineer at Blackpool, where there are a great many arc lamps used for street lighting, and the station being an alternating one, he used rectified currents for arc lighting.

Again, in his reply to the discussion raised on his paper, Mr. Hesketh said "that efficiency should be considered, not as from the terminals of the lamps to the terminals of the dynamo, but from the indicated H.P. to the measured illumination on the roadway. If this view were taken, then arc lamps fed by currents as closely approximating to continuous currents as possible, would give the best results."

Such remarks from one, who was actually connected with an alternating station which supplied a great number of public arc lamps, afford another proof of the fact that continuous current is superior to alternating for arc lighting purposes.

The next, and certainly the most important point in connection with the relative advantages and disadvantages of the two systems, is that in which the demand is that required for motors.

The aim of all central station engineers is to get as big a day load as possible. How can this be done? By getting as many motors as possible connected to the distributing network. A central station engineer also aims at keeping a continuity of supply, and does not care to see his lamps flicker and nearly jump out every few minutes. Yet this is what really happens on an alternating system, even when the number of motors connected is small.

An alternating station engineer will gladly receive any amount of applications for electrical energy for lighting purposes, but does not care to see one application for electricity for motive power, even if it be that required to run only a 1-H.P. motor.

The more motors there are connected to the distributing network of a direct current system the better. But not so with the alternating system.

There are about as many alternating current stations in the United Kingdom as continuous, yet the total aggregate horse-power of motors connected to the alternating is only about 820, whereas on the continuous there is a total horse-power of about 4,500 connected.

I think these remarks are sufficient to prove the superiority of direct systems over alternating for distribution; and also, from what I have said earlier on in my paper, you can see I am strongly of the opinion that the best system for distribution is low tension continuous.

The choice of a system will always depend upon the following:—

1. Area of supply.
2. Nature of demand; and
3. Situation of central generating station with respect to district to be supplied.

But I think that for distributors a three-wire low tension continuous (and, perhaps, in some cases a five-wire system may be used) will be found always suitable to the district, and always able to meet the demands of the consumers.

For feeders, if the distance between the generating station and feeding point is short, low tension continuous is preferable. If the distance is moderately great (say 3 miles) high tension continuous with transformers, (or, rather, motor generators) in sub-stations. If the distance is much greater than 3 miles, then multiphase feeders should be used, thus taking advantage of the fact that it is possible to transmit at higher voltages if the current be alternating than if it be continuous, due, as I have said before, to the absence in the alternating current apparatus of any commutator.

This is, perhaps, the only advantage of alternating current over continuous.

In conclusion, I desire to thank the hon. secretary of the Students' Section, Mr. Maurice Solomon, for his great kindness in reading this paper, on my behalf, before you this evening.

DELIVERY VAN AND OMNIBUS—CHAS. MILDÉ & CO.

The ironwork is constructed to receive according to requirements:—

1. The framework of a delivery van, with a central passage for the service, capable of carrying 600 kilos. with a driver and deliverer, or 750 kilos.

2. The framework of an omnibus with six inside and two box seats and convenience at the top for 180 kilos. of luggage.

The accumulators in both cases are disposed along each side of the central passage under the seats, and arranged so as to be drawn out from the back.

Rigid ironwork formed of two steel joists in the form of a rectilinear U, connected by cross pieces, supports the framework, which is fixed by bolts and the motor with the rotation bearings of the intermediary axle.

In front, two roller springs and one transverse spring, at the back two roller springs. Buffers for deadening shocks. Wheels with solid India-rubber tyres.

Axles guided by guard plates fixed to the ironwork and supported by jointed side pieces, which ensures to the axles a perpendicularity to the axis of the carriage and a constant parallelism whatever shocks there may be.

A guiding bandle, a vertical bar, two pinions toothed in the proportion of 1 to 3, a rolling chain and a jointed horizontal bar on the two pivots of the wheels.

An amperemeter to record the output of the charge and discharge.

A voltmeter and an ampere-hour meter register the charge and the discharge by means of a shunt, and enable us to note the energy supplied and expended for a given distance.

Forty elements constructed by the firm on a new model, the trials of which are not yet finished. These are distributed into four troughs of 10 elements placed along the sides of the car and grouped in series or in quantity.

Capacity, 145 ampere-hours at the normal rate of discharge at 36 amperes on level ground in four hours at 13 kilometres an hour. The track is 52 kilometres on level ground and 40 to 45 on varied ground.

The weight of one element is 175·5 kilogrammes, or 700 kilos. altogether.

The motor is of the Postel Vinay V4 type with series excitation, its normal power being 2,250 watts at 76 volts. Weight 200 kilos. Field magnet formed of two bobbins, and therefore four poles, drum armature.

The differential gear worked by the pinion of the armature is arranged on an intermediary axle turning in four bearings and supporting the two-toothed pinions which work by chains the toothed crowns connected with the driving wheels.

Ratio of reduction of the wheel to the intermediary axle, 1 : 5.

" " of the intermediary axle to the armature, 1 : 6, or 1 : 30 for the total ratio corresponding to 2,300 revolutions of the armature for 13 kilometres an hour.

Double differential and progressive brake, with core furnished with cushions of ash, and acting on two pulleys of the intermediary axle, worked by a double pedal placed under the driver's feet. The right pedal acts upon the left one, and cuts off the current before tightening the brake. The left one only cuts off the current. Safety brake, the two shoes of which, acting on the hind wheel, are arranged on a jointed cross-piece at the back. The brake is worked by a screw handle at the left of the driver and by a ratchet lever at the right of the seat.

The speed controller is placed in front opposite the driver, and consists of three pairs of concentric sectors placed vertically on a marble plate and provided with blocks, which are connected by a movable bar and a fly-wheel with a needle and dial. It effects the connecting of the battery in series or in parallel by means of a series of sectors arranged to the left, on the same axle, and the bar of which is hinged on to the right one by means of a connecting rod.

Forward Running Rate at Six Increasing Speeds.

4·5 kilometres an hour,	1st speed.	Battery in parallel, starting on rheostat 1.
6·5 "	" 2nd speed.	Battery in parallel, without a rheostat, 36 amperes 38 volts.
9·5 "	" 3rd "	Battery in parallel, shunt on field magnets.
13 "	" 4th "	Battery in series, without a rheostat, 36 amperes 76 volts.
16 "	" 5th "	Battery in series, 1st shunt on the field magnets.
20 "	" 6th "	Battery in series, 2nd shunt on the field magnets.

Position of rest, battery in series. Backward motion, three increasing speeds, battery in parallel, as for the three speeds for forward motion.

The controller enables the battery to be charged in parallel or in series according to the voltage available at the charging source. The weight of the carriage empty is 2,200 kilos, 1,330 on the hind axle and 870 on the front one. The distance between the axles is 1·55 metres. The width between the rails is the same as in tramway lines, 1·40 metres. The diameter of the fore wheels is ·75 metre; the diameter of the hind wheels is ·9 metre. Total length of the carriage, 3 metres; width, 1·85 metres.

Expenditure of energy on level ground, ·65 ampere-hour per kilometre-ton at a speed of 13 kilometres per hour.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

"Miscellaneous Notes on the Cheltenham Mains." By Mr. Hamilton Kilgour, Member. Read April 25th, 1899.

Among engineers who have had to do with central station work, it would probably be impossible to find a dissentient from the proposition that the means of distributing the electric energy are quite as important as the means of obtaining this energy from the source of energy available at the station, and it would be difficult to find many who could say that nine-tenths of their troubles and anxieties do not come from the outdoor works.

It seems strange, then, to find that engineering societies have devoted so much attention to the machinery and accessories of a station, and so little, in comparison, to its outdoor works, especially when it is remembered that the larger part of the station machinery is similar to that in common use for many other purposes, while the distributing works involve the use of plant of an almost entirely novel character.

The foregoing considerations, coupled with the invitation of your secretary, have led the author to write a few notes regarding mains, more with the view of inducing a discussion and a useful interchange of information among you than in the hope that he can contribute anything particularly interesting or useful himself.

At Cheltenham, electric supply is given for the most part by 100-volt and 200-volt distributors fed by sub-stations, which are themselves fed by 2,000-volt feeders from a principal sub-station, to which the large feeders from the works run untapped. There are two or three short independent low pressure distributors supplying groups of houses in outlying districts, and fed by street box transformers, which are supplied from high pressure distributors; in certain roads, where the houses are few and far between, high pressure distributors supply house transformers. The 100-volt distributors are being converted by degrees into 200-volt distributors, and the disadvantage of the increased cost of energy to the customers changed over is being met by giving a special rebate of 8½ per cent. to all supplied at 200 volts pressure.

The works lie at a distance of rather more than 2,000 yards from the principal sub-station, which is situated near the business centre of the town, and quite away from the residential and business districts; the plan of running untapped feeders to the principal sub-station and of distributing the energy from there by minor feeders has the advantage of practically placing the works at the principal sub-station in respect to pressure regulation, of giving the assistant in charge of the mains complete control of the whole system at a convenient place in the town, and—as happens from the configuration of the town—of reducing the cost of the feeders.

At the works duplicate high pressure bus bars, on to either of which any dynamo can be switched, are provided on a single-pole machine board; these two bus bars are connected through switches and meters to duplicate high pressure bus bars on a Ferranti feeder board. A Ferranti board has normally one high pressure bus bar, and the means of coupling together, independently of this bar, the inners of any two adjacent feeders; as it is of some importance to us to be able to put any dynamo on any circuit we have added a second bus bar above the first. In order to decrease the rate of accumulation of dirt on the bus bar insulators, and to make it impossible for the chain of the overhead traveller to touch high pressure metal, a horizontal slate slab has been fixed above the Ferranti board. The outers of all the feeders are coupled by links to a low pressure bus bar, as is usual on these boards, and this bar is permanently connected to earth; one pole of each dynamo is permanently connected to a bare copper strip, laid in a trench under the switchboard passage, and connected to the feeder board low pressure bus bar—the other pole of each dynamo being connected through its switch, fuse, and ammeter to one or other of the duplicate bus bars on the machine board.

A second and quite independent earth connection is also provided, and it is easy to test the resistance from one earth to the other, and so to ascertain at any time that both are good. The advisability of this duplicate earth, with a simple means of testing its efficacy, became apparent when the original earth wire of galvanised bullock cable (about 19/16) was found to have rotted through after a couple of years' use. The present earth wires are composed of heavy copper strip, and the one earth is made to a 3-inch water service from the town mains, and the other to an earth plate below the natural water level of the ground. I may add here that we have found galvanised iron cable quite useless for earth wires in many parts of the town, and now use large (about 19/15 to 19/14) iron wire cables thoroughly treated with a composition similar to that of Angus Smith.

The station meters are of the Thomson-Houston type, and the meters for the arc lighting feeders are of the new Westinghouse type. Hookham meters are quite unsuitable for arc lighting or motor circuits, on account of their inaccuracy on inductive loads.

There are at present four feeders, viz., two 37/16 to the principal sub-station, and two 19/18 to the arc lighting system for the west of the town. A fitted panel for a third feeder to the sub-station has been provided on the Ferranti board, and also three unfitted panels for future extensions.

All cables, other than those used for services, are concentric, and are insulated with bitumenised fibre and manufactured by Callender's Cable Company, and I may say that our experience with these cables has so far been very satisfactory. In a few of the principal streets unarmoured cables have been used, and these have been drawn into conduits composed of cement concrete with bituminised paper tube ducts; in most of the streets and roads, however, armoured cables have been used, and these have been laid—according to the nature of the soil—either direct in the ground or in wooden troughs filled in with bitumen. All armoured cables laid under roadways, whether in wooden troughs or not, have been protected with a layer of bricks placed across and above them, and in many cases—where there has been sufficient available depth—this protection has also been given to armoured cables laid under footways.

The sizes of high pressure cables used are 37/16, 19/16, 19/18 and 19/20; the first two sizes mentioned are used for feeders, the 19/18 only for the feeders from the works to the arc lighting system of the western section of the town, and the 19/20 for arc lighting circuits and for the riding mains referred to hereafter. All high pressure cables are tested *in situ* with an alternating current at a pressure of 4,000 volts and no faults have occurred, other than those caused by external damage, except on the 19/20 cables. In the 19/20 cables first laid the outer wires are not in contact with one another round the inner insulation, and this not merely renders this cable very susceptible of injury during laying, however great the care taken may be, but also causes—on any single wire parting at a factory joint—a difference of pressure between the slightly separated ends sufficient to produce sparking with a gradual destruction of the neighbouring insulation and finally a fault. Further, this bread and butter construction allows a greater freedom of motion to the wires of the outer conductor, and, if a joint on one of these parts when the cable is coiled on the drum, there is a considerable danger of one or other of the free ends penetrating the inner insulation when the cable is paid off the drum during laying. Several faults occurred on testing the arc lighting circuits with 4,000 volts pressure, and we now use 19/20 cables with a sufficient number of outer wires to completely surround the inner insulation, although this makes the outer conductor of considerably larger cross-sectional area than the inner in consequence of it being inadvisable to use wires smaller than No. 20 gauge.

In two or three cases it has been necessary to lay considerable lengths of feeders along roads having few probable customers but with good districts at their remote ends; in each of these cases a 19/20 cable has been laid alongside the district feeder in order to pick up customers on the way without tapping the feeder itself. About every 400 yards, more or less as has been necessary in different instances, a 4-way box has been fixed in these roads and the four ends of the

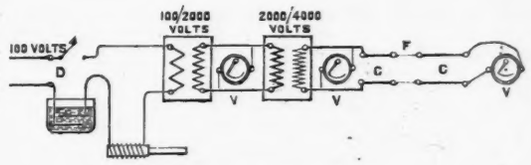


Diagram of 4,000-volt Test.

cables are coupled together in these boxes—the outers permanently to a low pressure bus bar and the inners through switch fuses to a high pressure bus bar. All customers in these roads are connected to the 19/20 riding main, and by pulling out the switch fuses at each end of any length of this cable a new customer can be connected without interrupting supply either to the district at the end or to the customers on other sections of the riding main. This arrangement is also useful in localising faults. Oil insulation is employed, and has been found fairly satisfactory.

Almost all high pressure services, whether to customers or to arc lamp transformers, are connected to the mains through double-pole switch boxes. The spindle of each switch projects through a gland in the top cover of the box and is covered by a little screw cap when not in use. To use the switch the cap has to be removed and a box spanner key applied. A slightly modified form of this box is used where an arc lighting circuit splits into two through a branch being taken down a side road; a concentric socket is then provided and connected to the branch main, and this socket is rendered accessible by a screw cap in the top cover above it. By means of a long concentric wall plug any branch main can be directly connected to testing apparatus after the switch has been opened. It will be obvious that the use of these boxes, one of which is exhibited, greatly facilitates the localisation of any fault, whether in the main, a branch, or a service. A modified form of the ordinary water hydrant box is placed over each box in order that the screw caps may be accessible without taking up roadway or pavement. These switch boxes, the hydrant boxes, and all other joint boxes are earthed, and in practically all cases the earth plates are the town water mains.

High pressure services to house transformers are made with 19/20 armoured concentric cable and services to arc lamp transformers with 7/18 armoured concentric cable; in each case, in all recent work, the outer conductor completely surrounds the inner insulation, and in every case the lead and the armour of the service cable are earthed both at the service joint and at the transformer.

From the principal sub-station feeders radiate to the sub-stations in its vicinity, in the case of the more important in duplicate, and from these sub-stations other feeders supply the more remote sub-stations and the high pressure distributors. The general arrangements of all the larger sub-stations are similar; each is divided into two parts, for high and low pressure apparatus respectively, by a wooden rail and in the high pressure part are the feeder dividing boxes, single-pole switchboards, and, as a rule, the transformers, while in the low pressure part are the distributor dividing boxes and double-pole switchboard. Each feeder dividing box will take three cables, and in it the outers are coupled to a low pressure bus bar, to

which are also connected two single cables by which this bar can be coupled to the corresponding bar of another box or to the low pressure terminals of the transformer primaries; the inners are jointed within the box, which is filled with insulating oil, to lead covered, rubber insulated single cables leading to a single-pole board on which they are coupled to a high pressure bus bar through switch-fuses. In the older sub-stations a similar switch-fuseboard is used for supplying the high pressure terminals of the transformer primaries—the bus bar of this board being connected to the feeder bus bar by cable. In the recent sub-stations a six-way board of the type shown on the drawing is used in place of the two three-way boards, and if there are more than three feeders another three or six-way board is added. All high pressure boxes are earthed, as are also the lead coverings of the high pressure cables and the transformer earth shields. With this mode of connecting the feeders together the effect of a fault is to blow the fuses at each of the two sub-stations, into which the faulty length of feeder enters. When the extensions now in progress have been completed most of the town sub-stations will have two independent sources of high pressure supply, so that high pressure can be cut off entirely from any one of these sub-stations without interfering with the supply to other sub-stations, and without—except at times of heavy load, as in the evenings—affecting the pressure appreciably on the low pressure distributors.

The sizes of the low pressure distributors used are 37/12, 37/15, and 19/14, according to the density of the demand and the pressure at which supply is given. In the sub-stations each distributor is jointed, in a small dividing box, to a pair of rubber-insulated single cables, by which it is connected to a pair of bus bars through a pair of switch fuses in the older sub-stations, and through a link and switch fuse in the more recent sub-stations. Cardew's earthing devices are used in the sub-stations for the protection of the low pressure circuits.

The town network of distributors is broken up into sections by the sub-stations, and a fault on any section (or service on it) merely cuts out that section by the fuses blowing at each end of it, and does not affect supply to other sections. Where a branch to supply a side street is taken off a distributor, a switch tee box with a testing socket, connected to the branch, is used, and for convenience in connecting new customers without disturbing supply to those previously connected to more than a minimum extent, we are breaking up the distributors in the principal streets by straight switch boxes, which are also provided with testing sockets. The average distance between sub-stations in the town is about 330 yards, so that the use of one or two switch boxes breaks up a section into either two or three sub-sections of 168 and 110 yards lengths respectively. In the cases, which are few, where high pressure feeders and low pressure distributors pass through the same conduit boxes, the cables are provided with distinctive labels. Practically all distributors are, however, armoured cables laid direct in the ground, and protected, where necessary, with wood troughs and bitumen from the action of the soil,

All the sub-stations, except the principal sub-station, are underground brick chambers with a backing of concrete outside the brick walls, and in the town they average about 10 feet by 7 feet by 7 feet high; where possible they are placed under footways, but in some cases it has been necessary to construct them under roadway, with the result that a much greater thickness of roof has had to be given. In the older sub-stations sewer manhole covers have been fixed centrally in their roofs, and movable iron ladders afford the means of descent into the low pressure parts; in the more recent sub-stations Hayward's lights, which are movable for lowering transformers, &c., are fixed in the roofs and side stairs provide the ordinary means of entrance for men—this method of construction produces a lighter and cleaner sub-station and does away with the central iron ladder. The concrete floors of the sub-stations are floated over with a layer of bitumen about 2 inches thick; upon the bitumen floor are placed wooden gratings, similar to those used in boats, and in the high pressure parts of the sub-stations rubber mats rest upon the wooden gratings and are kept clear of any water which may have accumulated between the days for cleaning. Ventilating pillars with pipes to the tops and bottoms of the sub-stations are provided, and where necessary and possible a sub-station has been drained through a trap to the sewers. The older sub-stations are not so drained but have small sumps in them; these, however, are not much needed as a sub-station, when fairly loaded, keeps perfectly dry. The walls and roofs of the sub-stations are painted with Blundell, Spence & Co.'s white petrifying paint, which gives a very good surface and one which can be washed without injury. The dividing boxes, switchboards, &c., are fixed on iron battens supported by irons built into the walls. All high pressure cables and work are painted red, and all low pressure cables and work are painted black.

Almost all the transformers used have been manufactured by the Brush Electrical Engineering Company, Limited, and out of a very large number comparatively few have broken down. With one or two exceptions the transformers, which have given trouble, have been small—almost all of the 650 watt size used for the arc lighting and placed in the bases of the arc lamp-posts. I think I may say that in practically every case the cause of breakdown has been damp; in any case breakdowns have been entirely stopped by treating the transformers as now described:—

First, short lead-covered cables are passed through the glands and connected to the primary and secondary terminals, and these glands and all openings into the transformer case, except the door to the fuses, are sealed up. The transformers are then taken in batches of six at a time into the principal sub-station, which is a hot dry room, where the primaries are connected in parallel to a 100-volt circuit, and the secondaries in series to a low resistance, by which the secondary current can be varied from about 8 to 15 amperes as desired. Pots of calcium chloride are inserted through the fuse doors, and then these doors are sealed up. The transformers are run in this way continuously for about a week, the calcium chloride being changed frequently at first and the fuse door resealed after each change. Towards the end of the week very little water is found to remain in the transformers, and at the end of this preliminary run each transformer is given a new quantum of calcium chloride, and is finally sealed up. They are then run individually for some hours, or perhaps a day or two, with their primaries connected to a 2,000-volt circuit, and their secondaries to arc lamps, and they are also flashed—primary to case—with 2,000 volts. As they have short leads already connected to them there is no occasion to open the transformer cases in the open air when they are being fixed in the arc lamp-posts.

(To be continued.)

MEASUREMENT OF CAPACITY OF LONG SUBMARINE CABLES.

In connection with Mr. Elton Young's paper, Mr. Arthur Dearlove has communicated the following to the *Journal of the Institution of Electrical Engineers*:—We are all indebted to Mr. Young for his paper, and the suggestions he makes with regard to the method he advises should be used when measuring the capacity of long cables, it represents undoubtedly some advance on the method of testing more usually employed, and I quite agree with Mr. Young that a recognised standard of "time of charge" with regard to this test should be adopted.

The writer first used the correction method and formula

$$C = K\frac{10{,}000 - (R \mp P)}{R \mp P}$$

in 1891, and pointed out in the *Electrician* of July 10th, 1891, that "no correction for leakage is found when the insulation resistance per microfarad is the same in the standard condenser and the cable compared, but the correction becomes necessary when large differences of absorption exist between the two capacities under test."

This is very obvious, but the formula just given combines a correction for both absorption and insulation resistance differences in the capacities compared, and, speaking from experience, this correction is a sufficient one.

There is very little or no evidence that the capacity of gutta-percha cables alters either under the influence of temperature changes or pressures, nor can, so far as I know, much evidence be found in tests of laid cables.

In the last paragraph of the appendix to Mr. Young's paper it is stated that "if any other method of I.C. measurement be employed, a definite time of charging becomes necessary for purposes of uniformity."

The following remarks bear on this point, when testing a cable of 1850 nautical miles and using the Muirhead correction I obtained results which perhaps might have been still better had Mr. Young's "balancing" system been employed, but as they stand they do not show any marked difference in the results obtained with the time of charge varying from 5 to 60 seconds. The particulars of these tests are:—

STANDARD CONDENSERS 80 MICROFARADS, GOTT METHOD WITH REVERSALS AND CORRECTION APPLIED.

Number of observations.	Time of charge. Seconds.	Time of mixing. Seconds.	Corrected results in microfarads.
4	5	5	768 6
12	10	5	772 3
6	20	5	775 4
8	30	5	773 4
10	40	5	775 3
6	50	5	775·8
5	60	5	775 9

Another series, taken on the same method using 241·2 microfarads as a standard, gave:—

Number of observations.	Time of charge. Seconds.	Time of mixing. Seconds.	Corrected results in microfarads.
4	5	6	772·7
4	10	6	774·4
4	20	8	775·2
4	30	8	776 1
4	60	10	776·4

The aggregate capacity of the cable from factory tests of the core at 75° F. was 776·81 microfarads.

In the above table the time of mixing given was found to have no very sensible effect in the final value.

The maximum difference shown in the latter figures when 241 microfarads was used as a standard, if the value of the 5 second charge is neglected is less than 0·3 per cent., a result which, if not showing uniformity, is very near to it; these tests are quoted as an instance of what may be done with the present known methods.

With regard to Mr. Young's remarks on the effect of temperature

on the capacity of gutta-percha cores, my firm, Messrs. Clark, Forde and Taylor, have made many experiments on this point, but the results arrived at are so discordant that though I mention the figures obtained, I do not think it probable that any definite law for this variation can be stated.

In one very complete series of tests with one coil of core kept at a temperature of 75° F., and used as a standard of comparison, whilst another coil of similar manufacture and dimensions was tested and compared at the different temperatures of 75, 60, 50, 42, and 35° F., the results showed that the capacity of the coil *increased* as the temperature was lowered to the extent of 0·8 per cent. for a range of 40° F.

As a check upon the foregoing a comparison of the capacity of each coil was made with a shellac condenser, the mean difference in capacity given by this method showed an increase of 0·94 per cent.

The average increase of capacity for this range stated, viz., 40°, would therefore be equivalent in the one case to ·02 per cent., and in the other ·023 per cent. per 1° F.

On the completion of the tests the second coil was raised again to a temperature of 75° F., and it was found that no sensible change of capacity had occurred by "ageing" effect.

When the two coils are at the same temperature the insulation resistance and absorption of both being alike, the correction for all times of change was found to be *nil*.

On the other hand, using a variety of gutta different from the above, two similar coils were tested in the manner described, and with these no change in their capacity occurred when their temperature was varied over a range of 40° F., whilst yet another pair of coils moved in the opposite direction, viz., *increased* temperature, resulted in *increased* capacity.

The variation of the capacity of gutta-percha coils due to changes of temperature is undoubtedly a very small one, and unimportant; moreover, it seems more than probable from our experiment that such variation that does occur is dependent on the nature and quality of the gum under test.

A NEW LIQUID INTERRUPTER.

Mr. E. W. Caldwell sends the following to our New York namesake whose editor has very kindly forwarded us advance proofs:—

The instrument, which I shall describe (when used as an interrupter for an induction coil) produces almost exactly the same effects as are obtained by the ingenious device of Dr. Wehnelt, and I think it is, perhaps, free from some of the uncertainty of action of that instrument.

The typical form of the instrument is shown in fig. 1, which is taken from the patent drawing. A receptacle made of an insulating material, and divided into two compartments by an insulating partition, through which a small aperture is left, is filled with a conducting liquid. Suitable electrodes are immersed in the liquid on either side of the partition, so that when current is sent through the apparatus from one electrode to another, it must pass through the

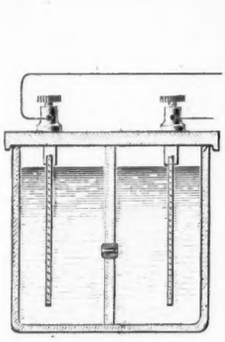


Fig. 1.

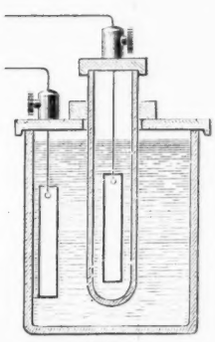


Fig. 2.

liquid which fills the aperture of the insulating partition. If this aperture be very small and the current relatively large, the heat developed at this point will form a bubble of steam which will break the circuit. As soon as the circuit is broken the source of the heat is removed, the bubble escapes, the two portions of liquid come again into contact and complete the circuit. This is repeated over and over again with astonishing rapidity, and if the interrupter be connected in series with the primary circuit of the induction coil, beautiful streams of sparks, resembling those obtained with high frequency mechanical interrupters, play across the secondary terminals.

It is probable that electrolytic action in this instrument is not at all essential to its operation, and that its action is entirely thermal.

So far I have tried only a few solutions for the liquid—dilute solution of sulphate of copper, a solution of sodium sulphite and a sulphuric acid solution of specific gravity of about 1·200.

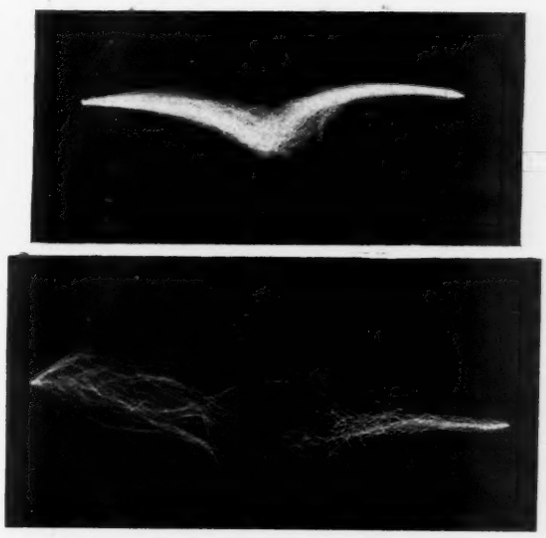
Of these the sulphuric acid gave by far the best results.

The instrument has also been operated by using mercury for the liquid conductor, but in the few experiments I have made the results obtained by the mercury were unsatisfactory, and the partition between the two parts of the liquid (which in this experiment was made of glass) was cracked and apparently burned in a very few minutes.

The frequency of interruption seems to depend upon the current strength, the diameter and length of the orifice, the inductance in the circuit and, to some extent, upon the temperature of the liquid and probably upon the capillary action between the liquid and the material forming the insulating partition. By varying the diameter of the orifice I have been able to obtain interruptions varying in frequency from about 5 per second to probably 400 or 500 per second.

I have noticed that when a large inductance is in the circuit the action seems to be much steadier. When there is no appreciable inductance in the circuit the interruption takes place, but irregularly. A rule that has been observed that when there is little or no

Spark about 7 Inches Long, Exposure 3 Seconds.



8-Inch Spark, Exposure about $\frac{1}{10}$ Second.

inductance in the circuit there is little or no spark formed by the break, but with a large induction coil in the circuit the orifice in the partition appears to be filled with fire. Notwithstanding this fact, however, the breaks seems to be very sudden and sharp. The discharge from the secondary seems to be unidirectional, and is very well adapted for exciting X-ray tubes.

Two of the figures show photographs of the spark, made when the interrupter was working with a frequency judged to be about 180 to 200 per second. These sparks were about 8 inches long.

A convenient form of the instrument is shown in fig. 2, where the insulating partition is formed by an ordinary test tube having a small hole in its side. With a coil in which about 6 or 7 amperes are used in the primary, and an orifice through the test tube about 1 millimetre in diameter, this arrangement gives a frequency from about 150 to 180 per second.

I have not, as yet, had an opportunity to make a careful experimental study of this apparatus, and I have no doubt that further work will develop many improvements in the practical details.

THE ELECTRIC LIGHTING OF FULHAM.

The question of the tenders for the supply of machinery, plant and mains for the electric lighting undertaking of Fulham was discussed at the adjourned meeting of the Fulham Vestry on Wednesday in last week. Previous to the Vestry meeting a meeting of the Electric Lighting Committee was held, when Mr. Hirst, of the General Electric Company, attended, and made an explanation regarding the ability of the firm to undertake a work of such magnitude. Mr. Hirst assured the committee that the whole of the work would be carried out in England, and that his firm was in a strong financial position to do all that was required. Mr. Hirst was examined by various members of the committee on difficult points, and then Mr. Medhurst, the electrical adviser to the Vestry, made a long statement practically to the effect that he did not consider the General Electric Company was properly equipped to carry out the heavy machinery required, although for some electrical work the firm had a high reputation. Mr. Medhurst also went fully into the allegation that the chairman of the Committee had been canvassed, and pointed out that Mr. Green had admitted having been called on by an agent of Messrs. Musgrave. He further strongly denied that it was at his suggestion that the General Electric Company sought to amend their tender in regard to the river pipe work, and that he took advantage of this to try and disqualify them.

At the Vestry meeting which followed, presided over by Mr. Drew,

the debate on the recommendation of the Electric Lighting Committee to give the contract to the General Electric Company, whose tender was £45,718 7s. 10d., was resumed. To this Mr. Sayer had at the last meeting moved an amendment that the tender of the British Insulated Wire Company for the mains, &c., at £14,152 18s. 6d., be accepted.

Mr. Budd strongly supported the amendment on the ground that by carrying out the recommendation of the Committee they would be going against the advice of the electrical engineer who was paid to advise them.

The amendment was defeated by 22 votes to 13.

Mr. Baxter next moved to add the following words to the recommendation:—"On condition that they produce sufficient evidence that the whole work will be or has been manufactured under trade union conditions of the respective trades, and penalties of £10 be added to the contract for each breach of these conditions, such penalty or penalties to be recoverable from the principal contractor." He contended that in a work of such magnitude it was incumbent upon them to insert the most stringent conditions. They had had bother with the builder who was erecting the generating station over the rate of wages, and it was to avoid such bother in the future that he moved that amendment, although bearing in mind the majority the reactionary party had in the Vestry, and the fact that they were a mere mechanical voting machine, he had no great hopes of it being carried.

Mr. Oakey seconded the motion, and said that not only was it a question of wages but a question of workmanship, and everyone would admit that trade unionists were the best workmen.

Mr. Wingfield said that it was for the engineer to see that the work was carried out in a proper way.

Mr. Steel pointed out that at present their contract clauses allowed them to declare the contract null and void if there were breaches, and they could have nothing stronger than that, and trade union officials he had consulted had stated that the clause of the Vestry could not be bettered. He thought it was not fair to try and get such a clause inserted at that stage, or the reactionary party might vote to eliminate the trade union clause altogether.

Mr. Lawson said the Vestry had long adopted the principle of trade union wages and conditions, and they certainly ought to insert the amendment.

Mr. Avern observed that Mr. Hirst had been before the committee and had stated emphatically that his company had had no trouble with their workmen, and therefore he could see no reason why they should object to such a clause. Some members seem to think because the General Electric Company was the lowest tenderers, therefore they must be a cutting company, but that did not follow, and he had pretty good evidence that the £750 quoted for the river pipes would amply cover that item, although it was said there would be a loss of £1,000.

After considerable discussion the amendment was carried.

Mr. Sayer proposed to move that the Vestry accept no tender that night, but advertise the work again in sections.

The Chairman pointed out that by carrying the last amendment they had adopted the recommendation of the Committee.

Mr. Sayer said the recommendation had not yet been put as the substantive motion, and when it was so put it would be open for him to move his amendment.

The Chairman held that Mr. Sayer would have that power.

Mr. Sayer said that if they accepted the tender that night it would be a scandal to London, and therefore he moved that fresh tenders be advertised for, and that the decision be left to the new Vestry to be shortly elected.

This gave rise to a very long discussion, and an appeal to Mr. Medhurst to address the Vestry.

Mr. Medhurst said he greatly deplored the personal matters which had been raised in connection with the tenders. Generally, he did not believe in advertising, because some of the best firms would not send in tenders to an open advertisement, but if there was any question as to whether he, or the chairman of the Committee, or anyone else was interested in the contract, it would be better to throw the whole thing open in a perfectly frank and honourable way. When he advised the Committee that the tenders should be asked for privately, nothing was further from his mind than that suspicion should attach to anyone. Rightly or wrongly, such suspicion had attached, and he did not see how they were to prevent people thinking there was something wrong, and therefore the whole thing had better be thrown open.

Several members pointed out that it was absurd to think that if they advertised the work in sections that it would be done more cheaply, because it was well known that sub-contractors would not undercut the general contractors in the open market.

Mr. Schuster said it was monstrous to hear the repeated talk of suspicion and stigma and scandal. If there was any suspicion against Mr. Green, let Mr. Medhurst, or anyone else, come forward and say so, for it was these insinuations of scandal that made public life in the vestries of London intolerable.

Eventually the amendment was defeated, and the recommendation of the Committee carried by 23 votes to 14.

A NOVEL FLY-WHEEL.

Until quite recently, when speeds of rotation have been raised so much above old standards, very little attention was paid to the design of fly-wheels. They were put together in a manner anything but scientific, and were not constructed in such a way as to be exposed to simple stresses. The stresses were complicated. Nominally a fly-wheel is a ring rotating about a centre, and this ring is supposed to be exposed to a bursting stress induced by centrifugal force. Such a force or ring stress is, in a plain ring, purely tensile. But a fly-wheel is seriously complicated by the fact that the ring is tied across at several diameters, and it cannot act purely by ring tension. It must either partially or wholly act as a series of partially continuous girders, the arms being the piers and the separate segments of the rim the girders.

Thus the arms, except for any cross breaking stress, due to velocity variation, are exposed to simple tension due to their restraint of the centrifugal tendency of the weight attached to their outer ends. When a wheel fails it may fail either because the rim is weak between the arms, or because the arms are too weak to stand the radial pull of the rim segments. In the one case the segments fail as girders; in the other case the arms fail as tension members. Given a sufficiency of arms to divide the rim into sufficiently short sections there can be no probability of cross breaking of the rim. In such a case a fly rim is merely the equivalent of so many weights each with its own radial tension rod. The calculation of such a wheel resolves itself into a question of arm tension, and such a wheel appears naturally to demand tension arms of some strong material. Cast-iron arms are unsuited for such a duty. Tension rods of steel are suited to it. But a fly-wheel boss and rim are constantly endeavouring to vary their angular positions Now the rim tries to lead the hub and again the hub is driven to lead the rim. This is the very essence of the duty of a fly-wheel and arms must act as cantilevers if they stand radially. Tension rods cannot so act. But if such tension rods are attached to the hub in a tangential direction, and from each point in the rim two such rods extend to opposite sides of the hub or bore they will be in a position to prevent angular difference in either direction between hub and rim. This, of course, is the bicycle wheel system.

In wire-wound fly-wheels, however, the rim is of maximum strength. Nothing known can be stronger than a rim wound of wire. In such a wheel any radial strength of the arms would be worse than useless, for it could only serve to reduce the directness of stress in the rim; it could only complicate the stresses. In a wire-wound rim and in the same category we may practically place all rims, which are jointed in a good and sufficient manner for ring tension there need be no radial connection of the arms and rim. The rim may best be driven by or drive the arms through the medium of cheeks which admit of a slight radial sliding motion. In a paper before the Civil and Mechanical Engineers' Society, Prof. A. Sharp deals with the question of fly-wheels generally. He finds that for equal weights wood is stronger than iron for the rims of wheels acting as girders between the spokes, and for equal strength an iron rim is $\sqrt{10}$ times as heavy as a wooden rim, so that for pulleys not needed as fly-wheels wood is in some respects a better material than iron or steel. His own pulley with bent wood rim and many spokes of round wood screwed in to act tangentially only weighs 16 lbs. for a pulley 24 inches $\times$ 5½ inches. He pointed out that the bending stress in rim segments is proportional to the square of the distance between the arms. His own iron design was a cast-iron rim with tangent spokes wrapped in pairs round the boss. He would screw up the spokes initially so as to compress the rim to such an extent, that at 100 feet velocity per second there will still be no rim tension. Such a rim could, theoretically, be an arch of cast-iron voussoirs drawn together by powerful tension. Obviously, the joints could not open until the ring stress exceeded the arch compression. The arms, in fact, bear all the load, and the calculation of such a structure is simple. No one need be in doubt as to the stresses to be resisted by every detail of the wheel.

At 100 feet per second the stress in a free rim of iron is only half a ton per square inch of cross-section. It is clear, therefore, that the bursting of many wheels must have been due to bad design, too much of the rim having been rendered inoperative as a stress bearer, or the ring stress has been prevented by the arms, and these have been too few to prevent the rim sections breaking as beams.

We are glad to see Prof. Sharp paying attention to the experiments of Wohler and Bauschinger, confirming, as they do, the early experiments of Fairbairn. Wohler's law, as enunciated by Launhardt, has not received the attention which it should have done, and much bad design in high speed crankshafts and other articles has been perpetrated by an inexcusable neglect of well-known facts.

PHYSICAL SOCIETY.

Ordinary Meeting held May 12th, 1899.

Prof. Perry, Vice-President, in the chair.

The Secretary read a note by Prof. W. B. Morton and Dr. Barton on the discussion of their paper "On the Criterion for an Oscillatory Discharge of a Condenser."

In the discussion which followed the reading of the paper it was pointed out that the result obtained, viz., that on taking into account the distribution of the current in the wire, a condenser, having the critical capacity on the simple theory, gives an oscillatory discharge—seems to be contradicted by the well-known fact that the resistance of the wire is greater, and the inductance less for oscillatory than for steady currents. The explanation of the apparent paradox is to be found in the effect of the damping on the inductance. When the damping is great and the frequency small, as in the neighbourhood of the critical case, what may be termed the equivalent inductance becomes greater than the steady current value. It is shown that this

increase in L outweighs the increase of R in its effect upon the criterion for oscillatory discharge. An examination of the expression for the equivalent inductance in the case of iron shows that it is greater than the steady current value if the ratio of one amplitude to the next is greater than

$$e^{\frac{n}{200}}$$

where n is the frequency of the oscillation. Since the decrease of L, with maintained oscillations, is due to a surface concentration of current, it is suggested that there must be an axial concentration in the case of damped vibrations. Following the method of Maxwell for determining the current density at a distance from the axis of a wire, an expression for the current was introduced containing a damping coefficient. The "quasi-amplitude" of the disturbance at any point in the wire was thus obtained. An examination of the result shows that making the damping zero indicates a surface concentration. If, on the other hand, the damping is great, the expression for the amplitude increases as the distance from the axis decreases and we get an axial concentration. Assuming sufficient damping to produce this effect it is shown that as we go through the point $r = \frac{a}{\sqrt{2}}$, where "a" is the radius of the wire we pass from a greater value of current density in the inner parts to a less in the outer than would correspond to a uniform distribution throughout the wire. From general reasoning the authors think that if a rapidly damped disturbance is propagated into a wire from its boundary, and if the oscillations are slow enough to allow the current to penetrate to the core we should expect to find an axial concentration in the latter stages of the phenomenon.

Dr. LEHFELDT said that Prof. Lodge had pointed out at the reading of the paper that the solution the authors obtained changed character at the critical resistance. As this point had not been considered in the note he supposed that the change in character made no difference to the results obtained.

The CHAIRMAN expressed his interest in the proof of the existence of an axial concentration.

Mr. ADDENBROOKE exhibited and described a "QUADRANT ELECTROMETER FOR APPLICATION TO ALTERNATING CURRENT MEASUREMENTS."

The author has substituted for cylindrical quadrants two sets of flat plates, the top set being adjustable. In this way the range of the instrument is considerably increased. The ability to remove one or more of the top quadrants makes the needle very accessible. By lowering the needle on to the bottom quadrants and then bringing down one of the top plates the instrument can be carried with safety. One of the top quadrants can be worked up and down by a worm gear, and by this motion the "electrical zero" of the electrometer is obtained. The suspension consists of a flat phosphor bronze strip, the torsion of which is found to be perfectly uniform, there being no fatigue effect. The case of the instrument contains windows so that the needle can be viewed from two directions at right angles, and there are screw motions to centre the needle with respect to the quadrants. To reduce the effect of air convection currents upon the needle the inside of the case is lined with cotton velvet. The quadrants are supported on brass bars passing through long ebonite sleeves in the bottom of the instrument. This gives good insulation without the use of sulphuric acid and there is no Leyden jar or condenser in connection with the needle. When using the electrometer idiostatically with the finest strip, a light needle and the quadrants $\frac{1}{10}$th of an inch apart, a difference of potential of 1 volt will produce a deflection of about 5 mms. upon a screen 2 metres distant. Using the instrument heterostatically with 100 volts on the needle, $\frac{1}{4}$th of an inch between the quadrants, and half a volt acting across them, a deflection of 200 mms. can be obtained. This sensitiveness is about 12 times as great as that got from instruments designed by Kelvin, Mascart, and Haga. Mr. Addenbrooke then showed how, in conjunction with a voltmeter and an ammeter, it was possible with his instrument to determine all the factors of an alternating current system. The increased sensitiveness of the electrometer renders it possible to measure currents of any magnitude with a very small waste of energy.

Mr. GASTER pointed out that the measurement of self-induction with an electrometer could only be carried out practically if the current curve was a sine curve. He said that in curves obtained from a Ganz motor a correction amounting to 7 per cent. had to be applied.

The CHAIRMAN said that even if the curve obtained was a sine curve, the electrometer was never used in this country for measuring self-induction.

Prof. HERSCHELL asked if it were possible to adjust the quadrants after the needle had been charged?

Mr. ADDENBROOKE then purposely disturbed the position of the adjustable plate, and after charging the needle reduced the deflection to zero by the worm gear. The author said that for high voltages the curve of calibration was different to that obtained from the ordinary formula.

The CHAIRMAN said that this discrepancy was probably due to want of perfect symmetry. In a paper read before the Royal Society by Perry, Ayrton, and Mather, it was shown that the presence of the guard around the mirror of an ordinary electrometer was sufficient to affect the needle when working with high voltages. In working with the plates very close together he was afraid the symmetry would be liable to be disturbed by a slight tilting of the needle due to electrostatic attraction.

The AUTHOR observed that the plates were only very close together when working with low voltages.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1899.

Compiled expressly for this journal by W. P. THOMPSON & Co Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, *to whom all inquiries should be addressed.*

9,072. "Improvements in thermopiles." E. D. YOUNG. Dated May 1st.

9,101. "Improvements in or relating to globes or protectors for electric and other lighting apparatus." J. G. PENNYCUICK and F. W. BARRETT. Dated May 1st.

9,134. "Improvements in or relating to electric accumulators." F. MOUTERDE. Dated May 1st.

9,209. "Improvements in and relating to electric arc lamps." R. UPTON. Dated May 2nd.

9,212. "Improvements in electric switches." J. D. F. ANDREWS. Dated May 2nd.

9,245. "Improvements in electric maximum demand indicators." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (F. P. Cox, United States.) Dated May 2nd. (*Complete.*)

9,246. "Improvements in apparatus for measuring electric currents." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (W. C. Fish, United States.) Dated May 2nd. (*Complete.*)

9,278. "Improvements in dynamo-electric or electro-dynamic machines." J. G. STATTER. Dated May 3rd.

9,290. "Improvements in or relating to electric sparking plugs." F. OLDFIELD and J. W. MILLIGAN. Dated May 3rd.

9,349. "Improved electro-magnetic tooth stopping hammer." C. OSTMANN. Dated May 3rd. (*Complete.*)

9,351. "Improvements in the manufacture and production of elements for secondary batteries or electric accumulators." H H. STRECKER. Dated May 3rd.

9,367. "An improved process for the production of accumulator plates." A. LEHMANN. Dated May 3rd.

9,414. "Improvements in controlling electric motors and apparatus for that purpose." H. LEITNER. Dated May 4th.

9,424. "Improvements in or relating to electric arc lamps." J. G. B. PETTS and J. BYRNE. Dated May 4th.

9,428. "Improved regulating mechanism for the carbon of electric arc lamps." J. ROSEMEYER. Dated May 4th. (*Complete.*)

9,429. "Improvements in electrical arc lamps." J. ROSEMEYER. Dated May 4th. (*Complete.*)

9,434. "Improvements in electric arc lamps." A. G. STOCKWELL. Dated May 4th.

9,436. "Improvements in electric telegraphic apparatus." E. CANTONO. Dated May 4th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, January 12 h, 1899, being date of application in Italy.)

9,437. "Improvements in electric telegraphic apparatus." E. CANTONO. Dated May 4th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, April 13th, 1899, being date of application in Italy.)

9,456. "Improvements in, or relating to, electric storage or secondary batteries." J. T. NIBLET and M. SUTHERLAND. Dated May 5th.

9,465. "A telephone automatic call register." T. BRIGGS and J. WALSH. Dated May 5th.

9,511. "Method of controlling several rotary phase current motors in an electrical railway train from one point of the train." SIEMENS BROS & Co., LIMITED. (Siemens & Halske Aktien Gesellschaft, Germany.) Dated May 5th. (*Complete.*)

9,512. "Improvements in voltaic batteries." C. D. ABEL. (La Société d'Etude des Piles Electriques, France.) Dated May 5th.

9,522. "Improvements relating to the distribution of electric current." B. G. LAMME. Dated May 5th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, October 6th, 1898, being date of application in United States.)

9,528. "Improved electro-magnetic apparatus for stopping and starting machinery and vehicles." C. W. HIGGS. Dated May 6th.

9,566. "Improvements in, and connected with, electric safety fuses." J. GRAY. Dated May 6th. (*Complete.*)

9,581. "Improvements in, or relating to, electrical devices or apparatus for controlling the pressure of small currents for electric lighting." F. W. SMITH. Dated May 6th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. THOMPSON & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free,* 9d. (*in stamps*).

1897.

10,056. "Improvements in rail bonds for electric railways, and in the method of making the same." W. B. CLEVELAND. Dated April

22nd, 1897. Relates to rail bonds: Heads are cast on to a flattened coil of flat wire. One side of the coil may be omitted. The heads are shaped and headed up in the rail ends. 9 claims.

10,197. "Improvements in or relating to dynamo and like electrical contact brushes." L. Boudreaux. Dated April 23rd, 1897. Consists in making dynamo and like electrical contact brushes of an alloy of copper, brass, or bronze with a small percentage of bismuth, antimony, or cadmium, or two or more of these metals combined. The alloy may be employed in the form of a bar or block, which may be provided with perforations for keeping it cool or receiving a lubricant. 5 claims.

10,250. "Improvements in electric arc lamps." W. P. Thompson. (F. Hansen, Germany.) Dated April 24th, 1897. Relates to a clockwork arc lamp. The carbons are hung by a chain on a wheel, rotatable in a frame, and geared to an escapement wheel and oscillatory balance wheel in this frame. The frame can be tilted about knife edges, which rest on supports in line with the periphery of the wheel, where the part of the chain extending to the upper carbon holder leaves it; thus, when the outer part of the frame is lifted by a link and lever connecting it with the core of a shunt magnet, the outer part only of the chain is lifted with the lower carbon. Contact is thus made, and the magnet dropping, the frame strikes the arc. The movements of the frame are controlled by a dash-pot. Feeding of the carbons by gravity is allowed when the frame is tilted sufficiently to withdraw a vane on the balance wheel from a stop, which is pivoted, and rests on the tilting frame. Loss in weight of the lower carbon is compensated by a chain attached to its holder. The magnet is adapted for alternating currents, to prevent great variation in its inductive resistance. The coil is wound on a non-metallic spool, and surrounded by a perforated sheet-iron casing. The movable core is tubular, and a hollow iron core is fixed within the coil. In order to keep the mechanism cool and clean, its base-plate is separated from a plate, carrying the carbon guides by two air spaces or layers of non-conducting material, and an intervening plate. These plates are connected by non-conducting screws. The chain passes through two tubes. 3 claims.

10,254. "An improved process for the manufacture of accumulator plates." W. H. Boese. Dated April 24th, 1897. Plates or electrodes are made by placing red lead in a boundary frame, and treating it with an acid, such as acetic, oxalic, or sulphuric acid, which combines with or decomposes the red lead, forming an insoluble or hardly soluble lead salt. The red lead may be mixed with binding materials, such as are described in Specifications No. 11,532, A.D. 1892, and No. 4,610, A.D. 1895. 3 claims.

10,280. "Improvements in electric incandescence lamps." F. Egger. Dated April 24th, 1897. Relates to incandescent lamps. The bulb is made with two grooves in its neck to receive a wire which is passed through holes in a cap, and is secured by twisting its ends together to attach the lamp to the cap. 1 claim.

10,295. "An electrically illuminated advertising balloon." J. Bussey. Dated April 26th, 1897. A captive balloon is in part transparent and preferably white to receive advertisements, which are illuminated by electric lamps within the balloon, the leads of the lamps passing along the holding cable. 3 claims.

10,429. "Improvements in underground conduits or trenches for electric railways and the like." J. D. Griffin and G. S. Small. Dated April 27th, 1897. Conduit or trenches for electric railways, &c., are formed of yoke frames having a continuous channel under the slot rails. The channel carries a continuous curved shield having a slot at the top, a guard shield being attached above the opening. The collector arm is curved to support the contact trolley which bears against the conductor carried by the arm. 3 claims.

10,439. "Improvements in secondary batteries." C. E. Lees. Dated April 27th, 1897. The battery comprises a closed cell, a cylindrical negative electrode of amalgamated copper gauze, an electrolyte consisting of a solution of cadmium sulphate, a porous cell closed at top and bottom, and a mass of active material, or material to be rendered active, surrounding a central leaden tube. 4 claims.

10,494. "Improvements in electric gas lighters." L. L. Borrodaile. Dated April 27th, 1897. Relates to lighting gas by electricity in pendent burners. The one electrical terminal is fixed on the burner tip and the second is carried by an arm of a lever on the gas cock. The free end of a coiled spring presses against the edge of the arm and holds the lever in the position shown until the handle is pulled. The part of the spring then presses against the side instead of the edge of the arm, and secures it in its fresh position until the lever is again actuated by the handle. 3 claims.

11,190. "Improvements in the electrolysis of fused chloride." F. M. Lyte. Dated May 5th, 1897. Relates to the electrolysis of fused zinc chloride as described in Specifications No. 7,594, A.D. 1893, and No. 15,813, A.D. 1895, and consists of methods of obtaining the fused zinc chloride in an absolutely anhydrous state. This may be done by (*a*) digesting the fused zinc chloride over fused or solid metallic zinc, or (*b*) by reversing the current—that is, making zinc the anode, and carbon, or a suitable heavy metal, the cathode. The result of either treatment is to prevent explosions and foaming during the electrolytic process for obtaining zinc and chlorine. 3 claims.

11,226. "Improvements in telephones." E. Priddle. Dated May 5th, 1897. The transmitter and receiver are arranged so that their cases fit together by means of a flange and semi-circular groove. The transmitter has a contact spring which cuts out the instruments from line when the receiver is at rest, but cuts in the instruments when the receiver is removed. The receiver is provided with a bell push. A pivoted case containing carbon granules is closed at the front by a carbon disc. The microphone and its connections are mounted in a disc or box held in the case by turn buttons. A permanent magnet is attached to the ring and carries polar extensions provided with coils. The contact spring is operated by the push and playing between contacts mounted on the insulation. The front of the case is closed by a diaphragm rear piece. 6 claims.

11,320. "An improvement in electric fuse heads for blasting and for other purposes." G. Pettinger. Dated May 6th, 1897. Relates to improvements on the electric high or low tension fuses described in Specification No. 11,283, A.D. 1895 The ends of the wires are now bent twice on themselves, their extremities bared and brought close together or bridged with fine wire. The tapered tube is used as before. 2 claims.

11,337. "Improvements in or relating to sockets or holders for incandescent electric lamps and the attachment of lamps thereto." A. J. Boult. (E. Worningen, Holland.) Dated May 6th, 1897. *Incandescent lamps* are secured in their caps by elastic metal bands placed round constricted parts of the necks of the bulbs, and having projecting parts engaging recesses in the necks, and perforations in the caps. The free ends of the band are pressed together and passed into an open slot. 2 claims.

11,594. "Improved switch for controlling from a distance electric motors for working guns, hoists, projectors, cranes, capstans or other electrically operated apparatus." G. Martinez. Dated May 10th, 1897. Relates to the arrangement of a switch for controlling from a distance, electric motors for operating guns, hoists, projectors, cranes, and other apparatus. When the contact is made the current is sent through the electro-magnetic switch which causes contacts to be made to operate the motor in one direction, while, when the other contact is made, the electro-magnetic switch is operated and the motor works in the reverse direction. 1 claim.

11,594A. "Application of electricity to the working of artillery." G. Martinez. Dated May 10th, 1897. Mountings.—Relates to electric training gear for turrets and platforms. The main electric motor is connected by a platform, and hand gearing is provided for rotating the turret by hand. A small electric motor is connected by the gearing and the clutch to the shaft of the main motor, and is employed for making small movements of the turret. The switches are those described in Specification No. 11,594, A.D. 1897, and the circuits to the motors are opened and closed by electro-magnets which are controlled by separate circuits, which are opened and closed from a distance by the proper officer. The keyboard has buttons, and for the quick and slow motions, for right or left movements, so that two buttons must always be depressed to produce any movement. 1 claim.

11,701. "Improvements in the construction of dynamo-electric machinery." A. Soames. Dated May 11th, 1897. Field magnets, frames.—The field-magnet consists of a pile of annular stampings which are secured concentrically in a cylindrical frame, carrying the armature bearings by means of a ring and type metal or other suitable material run in between them and the frame. The annular stampings are threaded on a mandrel, the axis of which is mounted in the armature bearings. The plates are clamped firmly together and the pile thus formed, together with a ring, it is then forced against an inwardly-projecting flange. After turning the structure on end, type metal or other suitable material is run into the annular space between the parts. 3 claims.

11,717. "Improvements in devices for enabling railway travellers to apply the brakes by electrical means." E. J. Preston and A. B. Gill. Dated May 11th, 1897. *Brakes.*—Consists of electric apparatus for enabling passengers to apply the brakes whether vacuum or compressed air. An arrangement is shown which consists of a pipe leading to the vacuum train-pipe, that is closed by a valve connected to the solenoid core. When the circuit is closed by the passenger the valve is raised and air then passes through openings to the train-pipe and applies the brake. In the other form the pipe leads to the train-pipe containing compressed air, and is closed by the valve which is pressed up to its seat by a spring. Upon closing the circuit the core pushes the valve downwards, thus permitting the escape of the compressed air, and thereby applying the brake. An electro-magnet may be employed in place of a solenoid. 2 claims.

11,808. "Improvements in incandescent electric lamps." A. Woodley. Dated May 12th, 1897. *Incandescent Lamps.*—Filaments are flashed in acetylene gas. They may be made from cellulose, carbonised and heated electrically in a glass vessel containing the gas, preferably rarefied, until the resistance of the filament has been reduced as desired. 3 claims.

11,861. "Improvements in, or relating to, electric accumulators or storage batteries." O. Lindner. Dated May 13th, 1897. Plates or electrodes are made by compressing a lead plate or roller between two metal plates, on the sides of which, adjacent to the lead plate, irregular surfaces have been formed by chipping or cutting the surface, or by fixing thereon metal filings, cuttings, or the like, pieces of minerals, or flint paper. The lead plate may be corrugated and provided with a frame, and is "formed" in any usual manner. 4 claims.

12,087. "Switch apparatus for the graduated inclusion and exclusion of resistances in electrical circuits." Siemens Bros. & Co., Ltd. (Siemens & Halske.) Dated May 15th, 1897. Resistance switches are, arranged with one set of contacts of carbon and the other of metal, such as copper. The switch arm is mounted to give a rolling contact. The carbon contacts are held in metal sockets, or clamps, and connected to the resistances. The moving contact consists of a roller, the spindle of which slides in slots in a frame, provided with a spindle and pivoted to the base. The spindle of the roller bears on a fork pressed outwards by a spring. In a modified form the contacts are fitted with springs, the spindle of the rolling contact being rigid. In the modification the contacts, which are in pairs, are mounted in frames free to tilt slightly and forced outwards by springs. Rollers rub on these contacts. 3 claims.